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JUL 76 VIEZEE, SIMMON, SHELAR, HACKWORTH
AFCEC-TR-76-20

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**U.S. DEPARTMENT OF COMMERCE
National Technical Information Service**

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SOURCE EMISSION INVENTORY FOR AQAM:
REVIEW OF A FIELD DATA COLLECTION PROGRAM

STANFORD RESEARCH INSTITUTE,
MENLO PARK, CALIFORNIA

JULY 1976

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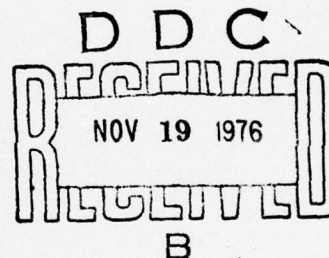
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**SOURCE EMISSION
INVENTORY FOR AQAM:
REVIEW OF A FIELD DATA
COLLECTION PROGRAM**

DIRECTORATE OF ENVIRONICS

JULY 1976



**FINAL REPORT:
1 DECEMBER 1975 - 30 JUNE 1976**

Approved for public release; distribution unlimited



AIR FORCE CIVIL ENGINEERING CENTER

(AIR FORCE SYSTEMS COMMAND)

TYNDALL AIR FORCE BASE

FLORIDA 32401

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efforts of data collection, it is recommended that, in addition to AFWL-TR-75-220, a data collection guide be issued in the form of a specific "shopping" list of data items and associated data sources that can be carried into the field by any technically qualified person.

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PREFACE

This report documents work performed during the period December 1975 through June 1976 by the Stanford Research Institute, Menlo Park, California, 94025, under contract F08635-76-D-0132 with the Air Force Civil Engineering Center, Air Force Systems Command, Tyndall Air Force Base, Florida, 32401. Captains Dennis F. Naugle and Bradford C. Grems, AFCEC/EVA, managed the program for the Center.

This report has been reviewed by the Information Officer and is releasable to the National Technical Information Service (NTIS). At NTIS it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

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SECTION I

INTRODUCTION

Under contract to AFCEC/EVA, Stanford Research Institute (SRI) collected detailed operational data of aircraft and motor vehicle air pollution emission sources at nine selected U.S. Air Force Bases. These operational data were reduced, coded for computer usage, and delivered to AFCEC for input into the U.S. Air Force/Argonne National Laboratory Air Quality Assessment Model (AQAM) which subsequently computed both total emission inventories and the resulting ambient air quality levels.

Table 1 lists the Air Force Bases that were visited and gives the schedule of data collection and delivery.

Prior to implementation of the field program, SRI was provided with the technical manuals entitled "A Generalized Air Quality Assessment Model for Air Force Operations," "AQAM Field Data Collection Guide," and "AQAM Operations Guide." These manuals described the various phases of data collection, data analysis, and data computer-processing involved in the Air Force's technique to assess ambient air quality levels on and in the vicinity of Air Force Bases. On the basis of the contents of these manuals, SRI prepared an initial field data collection plan, which was tested by contractor personnel and Air Force Project officers at MacDill AFB, Florida (see Table 1). It immediately became apparent that much of the required data was not always readily available in a properly documented format, but had to be reconstructed from interviews with knowledgeable base personnel or simply from subjective estimates. In some areas, notably the motor vehicle area, relevant data were often obsolete or nonexistent. Consequently, frequent deviations from the guidelines inferred from the "Field Data Collection Manual" were necessary.

Table 1. AIR FORCE BASES, RELEVANT DATA DELIVERY DATES, AND PERSONNEL INVOLVED IN THE FIELD DATA COLLECTION PROGRAM

Base	Visitation	Personnel	Data Package Delivery	Final Validation
MacDill AFB, Florida	15-19 December 1975	Walt Dabberdt, Bill Viezee, Patt Simmon, Gene Shelar	13 February 1976	3 May 1976
Nellis AFB, Nevada	5-9 January 1976	Bill Viezee, Chuck Flohr	13 February 1976	3 May 1976
Kelly AFB, Texas	5-9 January 1976	Patt Simmon, Gene Shelar	13 February 1976	5 May 1976
Tinker AFB, Oklahoma	19-23 January 1976	Patt Simmon, Al Smith	27 February 1976	7 May 1976
Davis Monthan AFB, Arizona	19-23 January 1976	Gene Shelar, Chuck Flohr	27 February 1976	3 May 1976
Luke AFB, Arizona	2-6 February 1976	Bill Viezee, Chuck Flohr	19 March 1976	3 May 1976
Grissom AFB, Indiana	2-6 February 1976	Patt Simmon, Al Smith	19 March 1976	20 May 1976
McGuire AFB, New Jersey	2-6 February 1976	Gene Shelar, Joyce Kealoha	19 March 1976	5 May 1976
Langley AFB, Virginia	23-27 February 1976	Patt Simmon, Gene Shelar	26 March 1976	14 May 1976

Since the field data collection program as carried out by SRI had no well-established, tested precedent, experience became an important factor. For example, when attempting to obtain data from interviews, it was found desirable to be as specific as possible in requesting information. In fact, experience indicates that the entire data collection program should be defined in terms of the specific data items that must be tabulated and processed.

The purpose of this report is to critically review the overall project so that the AFCEC in future efforts can benefit from the contractor's experience.

A recommended work plan for future field data collection is summarized in Section II. The work plan includes specific instructions for the contractor to arrange for the base visitation.

The currently available "Field Data Collection Guide" (AFWL-TR-75-220) presents general background information that is required to assess the magnitude and the scope of the field data collection program. A set of guidelines to be followed by personnel in the field can be condensed from its contents. There is a need, however, for a more specific, itemized set of guidelines on the basis of which operational data can be collected in a systematic, routine fashion. A review of the contents of AFWL-TR-75-220 and recommendations made on the basis of SRI's experience are presented in Section III. The very important area of motor vehicle source emissions and the technique introduced by SRI to collect and process the emission inventory data are described separately in Section IV.

With respect to off-base (Environ) emissions, SRI acquired the EPA NEDS and SAROAD data for the counties in which the nine selected AF bases are located. Also, available studies carried out by local air pollution control agencies were examined. The EPA NEDS data were found to be in a form that cannot be readily incorporated into AQAM. The effort required

to reduce and code the NEDS point source and area source data for input to AQAM was outside the scope of the contract. A brief summary of the NEDS and SAROAD data analysis problems is given in Section VI.

Final data summaries and information relevant to the data collection program are submitted in Section VII.

SECTION II

RECOMMENDED WORK PLAN

A. General

SRI's experience in collecting operational data of many air pollution emission sources at nine selected Air Force Bases, has demonstrated the need to more specifically outline and clarify the various tasks and responsibilities involved in the AQAM source emission inventory data collection program.

To promote a smooth interaction between the contractor's field team and the relevant base personnel, it was found advisable that the Base Environmental Coordinator serve as the principal contact for the contractor, and that he alert the various base facilities and base personnel prior to the actual visitation. Actions necessary to achieve such an arrangement should be covered in the work statement.

The work plan as outlined in the following paragraphs reflects the original statement of work as it evolved during the program, and includes some specific recommended actions for the preparation of the actual base visitation.

B. Work Plan

At this time, it is recommended that the work plan be defined in terms of the following phases:

- Phase 1. Preparation (pre base visitation)
- Phase 2. Data Collection (base visitation)
- Phase 3. Data Reduction and Coding (post base visitation)
- Phase 4. Data Delivery
- Phase 5. Data Validation
- Phase 6. Reporting

Phase 1. Preparation for Base Visitation

Under Phase 1, the following procedural steps are recommended:

- (1) AFCEC/EV will send an introductory letter to Base Command explaining rationale and objective of base visit by contractor personnel.
- (2) AFCEC/EV will provide contractor with name, telephone number, and mailing address of base person who will serve as the principal contact and coordinator for the base visitation (preferably Base Environmental Coordinator).
- (3) Contractor will contact the principal base person by telephone not later than one week prior to visiting the base to discuss the upcoming visit. Items to be mentioned include:
 - Number of persons on contractor's data collection team.
 - Data and time of arrival.
 - Suggested time schedule for the data collection, and base facilities and personnel to be contacted.
 - Introductory visit with Base Commander or Wing Commander.
 - Any desired data or information that must be computer-generated in advance (such as a USAF Real Property Inventory Listing).
- (4) Contractor will follow telephone contact with introductory information of the type shown in Appendix A. If required, security clearances for data collection team should be forwarded to Base Security Office.
- (5) All members of the contractor's data collection team will thoroughly study the "AQAM Field Data Collection Guide" and the AQAM "Operations Guide" prior to the collection of any data. An adequate number of Data Collection Sheets must be prepared.

Phase 2. Data Collection (base visitation)

The following steps are recommended for Phase 2:

- (1) After arrival at the designated base and prior to actual data collection, the contract's team shall report to the Principal Coordinator to schedule appointments with the relevant base facilities and knowledgeable base personnel. If instructed to do so by the Project Officer, the Coordinator shall arrange an introductory visit with Base Commander prior to any data collection activity.
- (2) The flow of action to collect the relevant data for the three emission source categories (Aircraft Sources, Airbase Sources and Motor Vehicle Sources) shall include, but not be restricted to, the outlines given in the "AQAM Field Data Collection Guide."
- (3) Wherever possible, the field data should be recorded on the appropriate Data Sheets. However, when relevant information can be collected in the form of available reports or standard tabulations, these data can be reduced and processed at a later time.
- (4) The contractor personnel shall keep a running record of the key personnel contacted at each base including names, telephone numbers, and data set numbers for which each provided information.

Phase 3. Data Reduction and Coding

All data collected at individual bases must be reduced, completed, and coded under this phase. Initial reduction of direct input data is accomplished by changing the data into a format consistent with the AQAM "Operations Guide" (AFWL-TR-75-307). Frequently, direct input data must be reconstructed using information obtained from interviews. Data gaps must be completed either by making estimates if no data were available or by obtaining additional input from telephone contact with the bases. Data accuracy can sometimes be checked, e.g., by multiplying operating times and fuel flows and comparing the results with the total fuel delivered to a facility. Data reduction should be done during trips to each base or shortly thereafter by the members of the original field data collection team.

The reduced data package must be coded and keypunched on an IBM 029 keypunch machine. This deck will be run (by the USAF) via terminal to a CDC 6600 computer. The data deck must be verified for errors and for differences from the format given in the AQAM "Operations Guide" with the use of the AQAM "Editing Code" which will be supplied to the contractor by AFCEC/EV.

Phase 4. Data Delivery

A complete AQAM Source Inventory input data card deck (029 keypunched and interpreted), one computer printed listing of the data, and one computer printed listing of the results from the AQAM "Editing Code" routine will be delivered to AFCEC/EV for each base.

Phase 5. Data Validation

Inconsistencies in the operational data provided by the Contractor are not detectable until after the preliminary AQAM analysis. The clarification of any processing and coding discrepancies in the input data decks will proceed as follows: (a) The contractor will provide data decks to AFCEC/EV in accordance with the delivery schedule; (b) AFCEC/EV will complete a source inventory and identify discrepancies or inconsistencies requiring further investigation;¹ (c) AFCEC/EV will provide the contractor with a copy of the AQAM Source Inventory describing apparent discrepancies or inconsistencies for each base as soon as possible. Each base will be handled individually. An estimated two weeks will be required to identify discrepancies to the contractor; (d) The contractor will verify that apparent discrepancies are correct or will make necessary corrections. The contractor is expected to investigate and correct these discrepancies as soon as possible. All discrepancies will be cleared no later than the required due date of the final report.

¹ An alternate procedure would be that the contractor first runs the AQAM emissions code before delivery of the input data card decks.

Phase 6. Reporting

Phase 6 will consist of the following steps:

- (1) The AQAM Source Inventory input data deck for each base must be accompanied by a brief narrative which should cover the following items as a minimum:
 - List of personnel contacted and interviewed at each base including names, telephone numbers, and data set numbers for which each provided information.
 - An explanation of any assumptions or coding modifications that were required due to AQAM limitations. Examples are: combining and coding several aircraft as one specific aircraft type since they are compatible from an emissions standpoint; or coding domestic heating oil as diesel fuel.
 - A list of AQAM Airbase Source ID numbers and their corresponding facility numbers and a one-line description of each.
 - Discussion of the rationale for any inputs to "Name List" which change default values.
- (2) At termination of the Delivery Order, the following items should be presented and forwarded to AFCEC/EV as the Final Narrative:
 - Base maps showing UTM coordinate grid and locations of all point, and line sources used. AQAM Source ID numbers and corresponding UTM coordinates should be plotted from the final computer card deck.
 - Demographic data including the number of assigned military personnel, civilian employees, family housing and dormitory residents, and retired personnel in the area.
 - The number of civilian vehicles currently registered on base.
 - The number of assigned aircraft by type.

- If emissions from any source or specific operational data items are estimated, the method should be explained in sufficient detail to permit verification of correctness.
 - Any abnormally large, widely dispersed, or other unusual sources. These should be noted and their features discussed.
- (3) Any additional information that the contractor feels would be helpful in analysis of the AQAM output should be included.

SECTION III
TECHNIQUE OF AIRCRAFT EMISSION INVENTORY
DATA COLLECTION AND HANDLING

A. General

The SRI personnel involved in the AQAM Source Inventory data collection and reduction program carefully studied the contents of the following manuals prior to the AF base visitation:

- (1) "AQAM Field Data Collection Guide," AFWL-TR-75-220.
- (2) "A Generalized AQAM for Air Force Operations--An Operators's Guide," AFWL-TR-74-54.
- (3) "AQAM Data Reduction and Operations Guide," AFWL-TR-75-307.
- (4) "USAF Aircraft Pollution Emission Factors and Landing and Takeoff (LTO) Cycles," AFWL-TR-74-303.

Knowledge of the contents of these manuals was essential in the initial assessment of the magnitude and scope of the inventory data collection program, and in the formulation of the method of approach and the preparation of an initial test plan.

In the light of SRI's experience in collecting emission source data at nine different AF bases, comments and recommendations with respect to the contents of AFWL-TR-75-220 are presented below.

B. Review of "AQAM Field Data Collection Guide,"
AFWL-TR-75-220

The "AQAM Field Data Collection Guide" proved to be a comprehensive background manual for assessing the magnitude and scope of the data collection program. However, as a guide to be carried out in the field by an inexperienced team of contractor personnel, it is too descriptive

and lacks a well-organized, specific summary outline of operational steps. Its contents may be reduced and summarized on the basis of the following comments and recommendations. Each section of the Manual is treated separately. Since stationary (airbase) sources were surveyed at only one of the nine selected air force bases, Section III-2 is eliminated from extensive discussion.

Section I

No comments.

Section II

1. Base Briefings

Each base command should be familiarized with the rationale and objectives of the AQAM Inventory Program by AFCEC prior to base visit. Contractor personnel should be introduced to Base or Wing Commander and other principal base supervising personnel (e.g., DCO, DCM) by Base Environmental Coordinator. No briefings by contractor personnel to explain rationale of Inventory Program should be required.

Section II

2. Specifically, the following maps should be obtained through the Base Civil Engineering Office:

Tab No.:	A-1	Environmental Narrative for Base Comprehensive Plan
	B-1	Regional map
	B-2	Vicinity map
	C-1	Base Master Plan
	C-1.1	Aircraft Parking Plan
	C-2	Smaller version of Base Map
	C-7.1	Aerial Photo Map
	G-2.1	Pollution Control Map
	C-7	Liquid Fuel System (storage tanks, pipe lines, dispensing pumps, etc.)

In case of construction:

F-1 Development Plan

F-1.1 Aircraft Parking Plan

For many bases where only aircraft and motor vehicle sources had to be covered, Tab No. C-1 and C-1.1 were found to be adequate.

The procedure for acquiring the UTM coordinates is indicated in Figure 1.

Section II

3. Atmospheric Data

Obtain through the Base Weather Station:

- a. Average annual temperature (degrees F)
- b. Annual degree days
- c. Pressure altitude (hundredth of ft)
- d. Annual average wind speed ($m\ sec^{-1}$)
- e. Daily average temperature variation (degrees F)

Section II

4. Aircraft and Base Strength

Obtain through the Base Civil Engineering Office:

- a. Assigned military personnel
- b. Assigned civilian personnel
- c. Retired military personnel in area
- d. Number of family housing units
- e. Number of mobile home spaces
- f. Number of registered privately owned vehicles
- g. Dormitory units and BOQs
- h. Number of base-assigned aircraft by type.

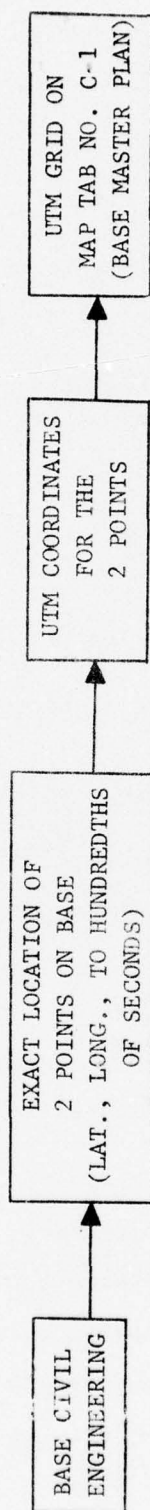


Figure 1. Acquisition of UTM Coordinate System

Section III

1. Aircraft Sources

It is recommended that the procedures to collect Aircraft Source Emissions Inventory data be discussed under the following four sub-headings: (a) Aircraft Flight Operations (LTOs); (b) Runways, Taxiway Paths and Parking Areas; (c) Aircraft Ground Equipment (AGE); and (d) Fuel Distributions.

a. Aircraft LTOs

The following specific comments on the topics discussed under this subheading in AFWL-TR-75-220 are presented.

Page 14--It was found very difficult, if not impossible, to obtain accurate LTO data from available fuel distribution information. Therefore, the practicality of the contents of the second paragraph on page 14 is questioned.

Page 22--From an organizational standpoint, instructions for completing Data Sheet 5 (Runway Data) could be discussed better under Subheading b, Taxiway Paths and Parking Areas (page 30).

Page 24--Instructions for completing Data Sheet 6: Pilot Survey, could be moved up to replace the Runway Data Sheet 5, in order to follow, more logically, the aircraft LTO information of Data Sheets 1, 2, 3, and 4.

Page 26--Pilot Survey Summary Data Sheets 7 and 8 can probably be eliminated. When visiting an air force base with different types of assigned aircraft, it was found, that one interview with one pilot experienced on a particular aircraft type was adequate to provide representative information on the aircraft's LTO cycles.

Figure 2 shows the flow of action recommended to collect aircraft LTO information.

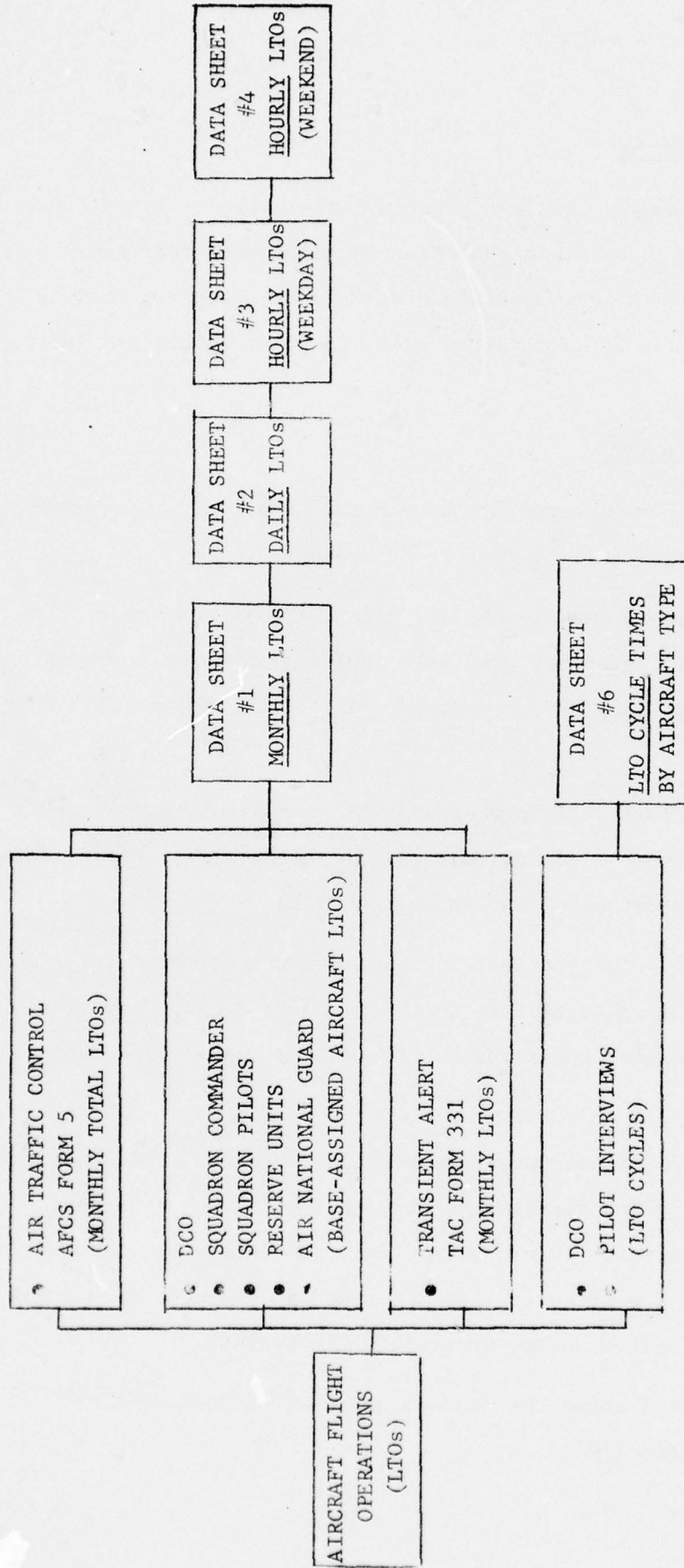


Figure 2. Aircraft Landings and Takeoffs (LTOs) Data Collection Flow Chart

b. Taxiway Paths and Parking Areas

The Runway Data Sheet (Data Sheet 5, page 22) should be reorganized under this subheading.

Page 35, 36--Data Sheet 12 could probably be eliminated from the field data collection program. SRI's experience indicates that all required information on runways, taxiways and parking areas can be readily documented and recorded on a reduced copy of the base map (Tab C-2). Reduction of these data to a format compatible with that required for Data Sheets 10 and 12 can be done at a later time.

Figure 3 shows the flow of action recommended for the collection of data on runways, taxiways, and aircraft parking areas. Eventually, renumbering of the Data Sheets may be advisable.

c. Aircraft Service Vehicles and
Aerospace Ground Equipment (AGE)

Under this subheading, the Manual appears too detailed considering the low-resolution operational data that are currently available. All AGE-related information had to be obtained from interviews, and its credibility was found to be highly dependent on the particular individuals interviewed.

Page 38, 39--Until detailed, high quality data records on AGE usage become available, it is recommended that Data Sheets 13, 14, and 15 be simplified and combined into a single Data Sheet 13. Figure 4 shows the revised data sheet used by SRI.

The data sheet is divided into two categories of AGE usage which are: routine (those operations that relate directly to flying) and nonroutine (maintenance). While routine AGE emissions can be determined and assigned per LTO cycle, the nonroutine AGE emissions, if extensive, should probably be assigned as an area source (e.g., Kelly AFB and Davis-Monthan AFB).

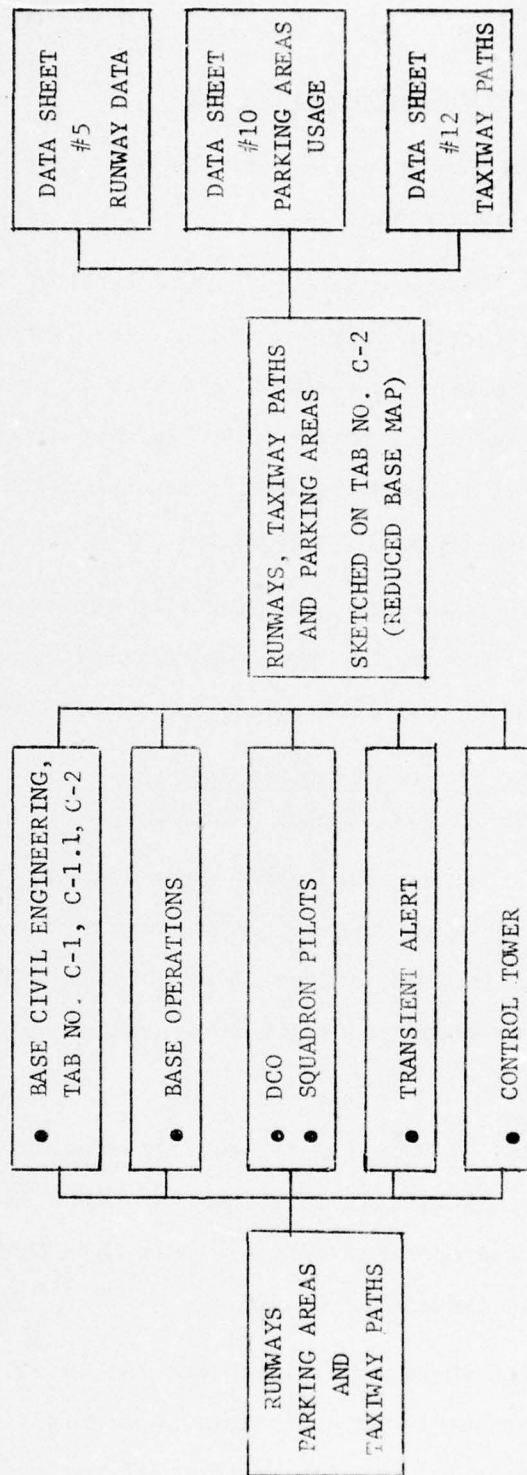


Figure 3. Flow of Actions Recommended for the Collection of Runway, Taxiway Paths and Aircraft Parking Area Data

Aircraft Type _____

Equipment	Routine	Nonroutine
	Average	Time in Use
<u>COMPRESSOR:</u> MA-1A Gas Turbine Compressor (JP-4) MC-1A Air Compressor ("High Pack") MC-2A Air Compressor ("Low Pack") Other: (specify)		
<u>GENERATORS:</u> AM32A-60 Gas Turbine Generator (JP-4) AM32A-60A Gas Turbine Generator (JP-4) MD-3 Generator Set (C-26) M-32A-10 Generator (Gas) Other: (specify)		
<u>HEATERS:</u> BT-400 (H-1) Heater Other: (specify)		
<u>COOLERS:</u> M32 Air Cooler		
<u>TEST STANDS:</u> TTU-228E Hydraulic Test Stand MU-2A MK-3 + 3a (electric) D-5 D-6 + 6a (electric)		
<u>LIGHT CARTS:</u> NF-2 Light Cart		
<u>OTHER AGE EQUIPMENT NOT COVERED ABOVE:</u> Towing Tugs		
<u>SPECIALIZED OPERATIONAL EQUIPMENT:</u> MJ-1 Bomb Lift MJ-4 Bomb Lift		

Figure 4. Summary Data Sheet for AGE

Page 44--Data Sheets 17, 18, and 19 were not used because the high-resolution input data required were not available.

In order to effectively collect the essential operational data on AGE, it is recommended that subheading c of the Manual include a summary description of the AGE data reduction procedure as follows:

Specific information required for AGE data reduction:

- # 1. Total gallons of JP-4 consumed per year by AGE (from Fuels Management Branch).
- # 2. Total gallons of Mogas consumed per year by AGE (from Fuels Branch).
- # 3. Total annual number of hours of JP-4 powered AGE used per aircraft type (from an interview with DCM, Crew Chiefs, Transient Alert, using summary data sheet of Figure 4).
- # 4. Total annual number of hours of Mogas powered AGE used per aircraft type (from an interview with DCM, Crew Chiefs, Transient Alert, using summary data sheet of Figure 4).
- # 5. Total annual number of hours of JP-4 powered AGE used by all aircraft (Sum #3 for all aircraft types).
- # 6. Total annual number of hours of Mogas powered AGE used by all aircraft (Sum #4 for all aircraft types).
- # 7. Average JP-4 fuel consumption by AGE
[gallons per hour ($\#1/\#5$ gallons per hour)]
- # 8. Average Mogas fuel consumption by AGE
[gallons per hour ($\#2/\#6$ gallons per hour)]
- # 9. Annual number of gallons of JP-4 used per aircraft type ($\#3 \times \#7$).
- #10. Annual number of gallons of Mogas used per aircraft type ($\#4 \times \#8$).
- #11. Gallons of JP-4 per LTO for each aircraft type ($\#9/\text{annual LTO}$).
- #12. Gallons of Mogas per LTO for each aircraft type ($\#10/\text{annual LTO}$).

Pollutant emissions are computed directly from #11 (JP-4 powered AGE) and #12 (Mogas-powered AGE) according to the procedure outlined in Section V, pages 138, 139 of the Manual.

The above listing provides a clear definition of the specific data items to be collected in the field. A useful check on the consistency of AGE data collected for several bases is obtained by an intercomparison of #7 and #8. These items represent the average fuel consumption of standard AGE equipment and should not differ too much from base to base. It is probable that estimates of #7 and #8 can be obtained directly from the interviews.

The flow of actions to collect the AGE emission inventory data is shown in Figure 5. Eventual combination and renumbering of the data sheets is recommended.

d. Fuel Distributions, Spillage, and Venting

Page 49, 52--SRI designed a new format Data Sheet 22 which is shown in Figure 6. It provides tabulation space for the three types of fuel distribution data required. These data were readily obtained from personnel in the Fuels Management Branch. It was found expedient to allow the Fuels Branch personnel several days to gather the data and fill out this data sheet.

Major and minor fuel spills are obtained from the Base Fire Department where a record is kept of all spills down to one gallon. A data sheet of the type shown in Figure 7 was found better suited to document fuel spillages than the Data Sheets 20 and 21 printed on pages 50 and 51 of the "Field Data Collection Guide." The data sheet should be presented to the Fire Chief and several days should be allowed for his staff to provide the data.

Page 53--Fuel venting was invariably considered negligible (one to two pints) by both pilots and maintenance crews.

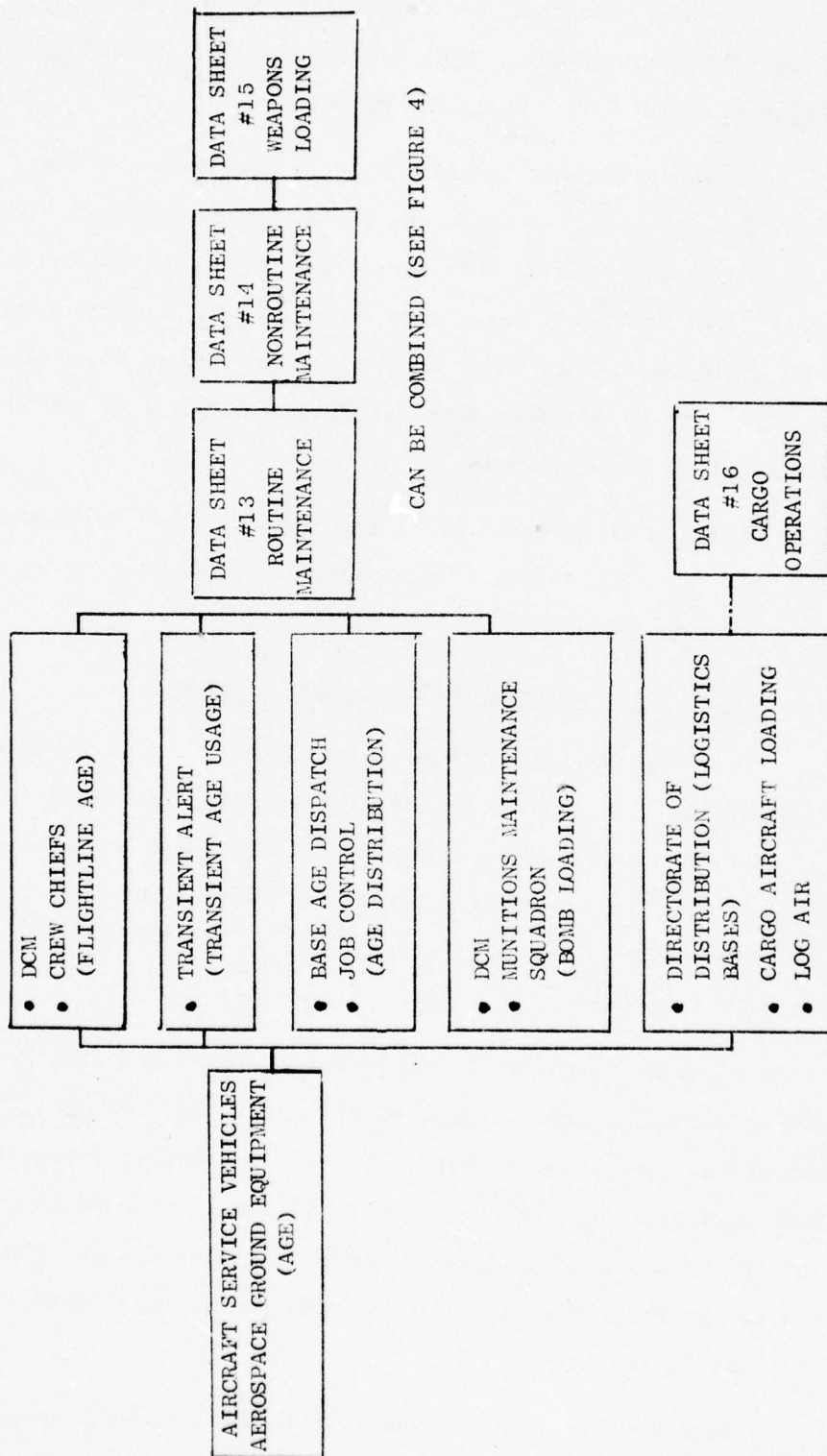


Figure 5. Recommended AGE Emissions Inventory Data Collection Flow Chart

AIRCRAFT FUEL DISTRIBUTION

1. TOTAL GALLONS OF FUEL DISTRIBUTED TO AIRCRAFT PER MONTH

Month	JP-4	Av. Gas
Jan		
Feb		
Mar		
Apr		
May		
Jun		
Jul		
Aug		
Sep		
Oct		
Nov		
Dec		

2. NORMAL AMOUNT DELIVERED TO AIRCRAFT TYPE

Aircraft Type	JP-4	Av. Gas

3. TOTAL GALLONS OF FUEL DELIVERED TO AGE PER YEAR

AGE Unit	Location	JP - 4	Mogas	Diesel Fuel

Figure 6. Comprehensive Data Sheet for Fuel Distribution Data

MONTH	FUEL SPILLS	LOCATION			
JANUARY	TOTAL NUMBER				
	TOTAL GALS				
FEBRUARY					
MARCH					
APRIL					
MAY					
JUNE					
JULY					
AUGUST					
SEPTEMBER					
OCTOBER					
NOVEMBER					
DECEMBER					

Figure 7. Fuel Spillage Data Collection Sheet Used by SRI
to Replace Data Sheets 20 and 21 of the Manual

All required fuel information can be summarized according to the flow chart shown in Figure 8.

Section III

2. Airbase Sources

Since SRI conducted a complete emissions inventory for stationary airbase sources at only one airbase (Langley AFB, Virginia), no description of contractor developed methods of data collection and handling can be given and no recommendations can be made on the basis of experience. Data, however, were collected, under the category of Engine Test Facilities, on engine trim pads. Trim pads involve facilities and locations where engine tests are performed with the engine placed in the aircraft. Three test configurations are distinguished in the collection of emission inventory data:

- a. engine tests with a noise suppressor
- b. engine tests with a vertical deflector
- c. engine tests without a or b.

Operational data on engine trim pads were collected by the SRI field teams and entered directly on Data Sheets obtained from cards 1, 2, and 3 of Data Sets 14 and 15 of the "Operations Guide" (AFWL-TR-75-307). Thus, the coding sheets (Figures 9 and 10) were used in lieu of the Data Collection Sheets 25 and 26.

C. Summary of Comments on Aircraft Emissions Inventory

SRI's experience suggests that a field data collection guide is required which provides a comprehensive and specific outline of steps to be followed by a data collection team. The manner in which the contents of AFWL-TR-75-220 on field data collection for aircraft sources can be reorganized, and data collection sheets can be combined, reformatted, or totally eliminated were described in the preceding paragraphs. If a

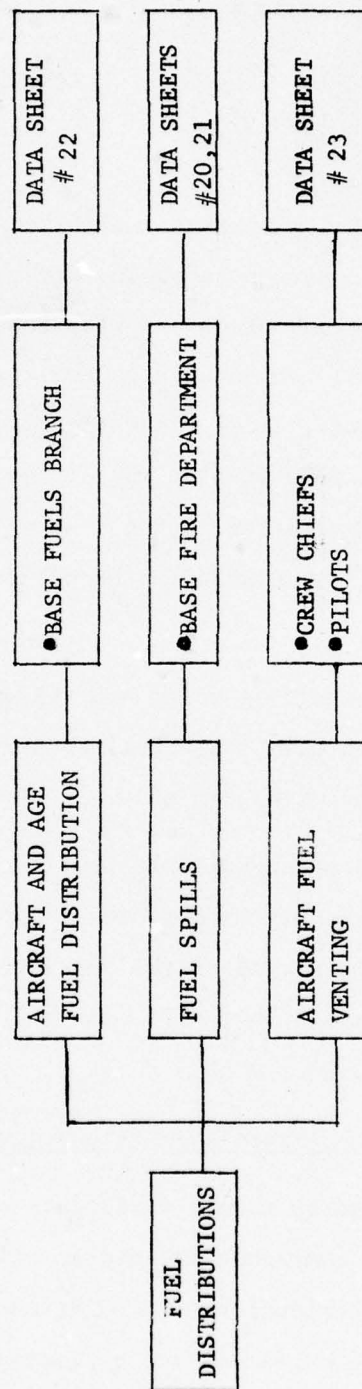


Figure 8. Flow Chart Recommended for the Collection of Fuel Data

CARD NUMBER 1		FORMAT (I4)		DATA SET 14	
<u>card</u> <u>columns</u>	<u>unit</u>	<u>definition</u>		<u>totals</u>	
1-4	-	Total number of test cell sites to be described.			

Note: If this value is zero skip to the next data set.

Figure 9. Coding Sheets for (1) All Test Cells with Engine Out of Aircraft
and (2) Engine in Aircraft with Sound Suppressor

card columns	unit	definition	<u>totals</u>
1-4	-	Four digit source ID number which is larger than the previous airborne or environ ID defined.	
8	-	Total number of engine types being tested at this site.	
9-16	Km	X coordinate at the source center.	
17-24	Km	Y coordinate at the source center.	
25-32	Meters	Height of the exhaust stack above the surrounding ground level. (If left blank, a value of 10.0 will be used.)	
33-40	Meters	Initial horizontal dispersion parameter. If left blank, a value of 10.0 will be used.	
41-48	Meters	Initial vertical dispersion parameter. (If left blank, a value of 10.0 will be used.)	
49-56	^o Kelvin	Temperature of the gas at the exit of the exhaust stack. (If left blank, a value of 598.6 will be used.)	
57-64	Meters/Sec	Velocity of the gas at the exit of the exhaust stack. (If left blank, a value of 12.5 will be used.)	
65-72	Meters	Diameter of the exhaust stack. (If left blank, a value of 9.0 will be used.)	
73-80	Meters	Height of the test cell building (not including the exhaust stack) above the ground. (If left blank, a value of 10.0 will be used.)	

<u>card columns</u>	<u>unit</u>	<u>definition</u>	<u>totals</u>
1-4	-	Four-digit source ID number which is identical to the source ID in Card 2.	
5-8	-	ID of aircraft engine tested at this site. (choose from Table 3).	
9-16	-	Annual number of tests of this engine at this site.	
17-24	Min/Test	Average time this engine type is tested in this test cell in the IDLE mode.	
25-32	Min/Test	Average time this engine type is tested in this test cell in the NORMAL mode.	
33-40	Min/Test	Average time this engine type is tested in this test cell in the MILITARY mode.	
41-48	Min/Test	Average time this engine type is tested in this test cell in the AFTERBURNER mode.	

CARD 3 IS REPEATED FOR EVERY ENGINE TYPE BEING TESTED IN THIS TEST CELL AND THE NUMBER OF REPETITIONS MUST EQUAL THE TOTAL NUMBER OF ENGINE TYPES PUNCHED IN CARD 2, COLUMN 8. CARD 2 WITH AN ASSOCIATED SET OF CARD(S) 3 IS REPEATED FOR EVERY TEST CELL USED AT THIS BASE AND THE NUMBER OF REPETITIONS MUST EQUAL THE VALUE PUNCHED IN CARD 1, DATA SET 14.

Figure 9. (continued)

CARD NUMBER 1		FORMAT (14)		DATA SET 15	
<u>card</u> <u>columns</u>	<u>unit</u>	<u>definition</u>		<u>totals</u>	
1-4	-	Total number of runup stand sites to be described.			

Note: If this value is zero skip to the next data set.

Figure 10. Coding Sheets for Engine in Aircraft with Vertical Deflector
or no Deflector

FORMAT(214,9F8.2)

CARD NUMBER 2

<u>card columns</u>	<u>unit</u>	<u>definition</u>	<u>totals</u>
1-4	-	Four digit source ID number which is larger than the previous airbase or environ ID defined.	
8	-	Total number of engine types being tested at this site.	
9-16	Km	X coordinate at the source center.	
17-24	Km	Y coordinate at the source center.	
25-32	Meters	Height of the exhaust stack above the surrounding ground level (horizontal stack is assumed). (If left blank, a value of 5.0 will be used.)	
33-40	Meters	Initial horizontal dispersion parameter. (If left blank, a value of 5.0 will be used.)	
41-48	Meters	Initial vertical dispersion parameter. (If left blank, a value of 5.0 will be used.)	
49-56	°Kelvin	Temperature of the gas at the exit of the exhaust stack. (If left blank, a value of 0.0 will be used.)	
57-64	Meters/Sec	Velocity of the gas at the exit of the exhaust stack. (If left blank, a value of 0.0 will be used.)	
65-72	Meters	Diameter of the exhaust stack. (If left blank, a value of 0.0 will be used.)	
73-80	Meters	Height of the runup stand above the ground. (If left blank, a value of 5.0 will be used.)	

Figure 10. (continued)

FORMAT(2I4,4F8.4)

CARD NUMBER 3

<u>card columns</u>	<u>unit</u>	<u>definition</u>	<u>totals</u>
1-4	-	Four-digit ID number which is identical to ID in Card 2.	
5-8	-	ID of aircraft engine tested at this site. (choose from Table 3).	
9-16	-	Annual number of tests of this engine at this site.	
17-24	Min/Test	Average time this engine type is tested in this runup stand in the IDLE mode.	
25-32	Min/Test	Average time this engine type is tested in this runup stand in the NORMAL mode.	
33-40	Min/Test	Average time this engine type is tested in this runup stand in the MILITARY mode.	
41-48	Min/Test	Average time this engine type is tested in this runup stand in the AFTERBURNER mode.	

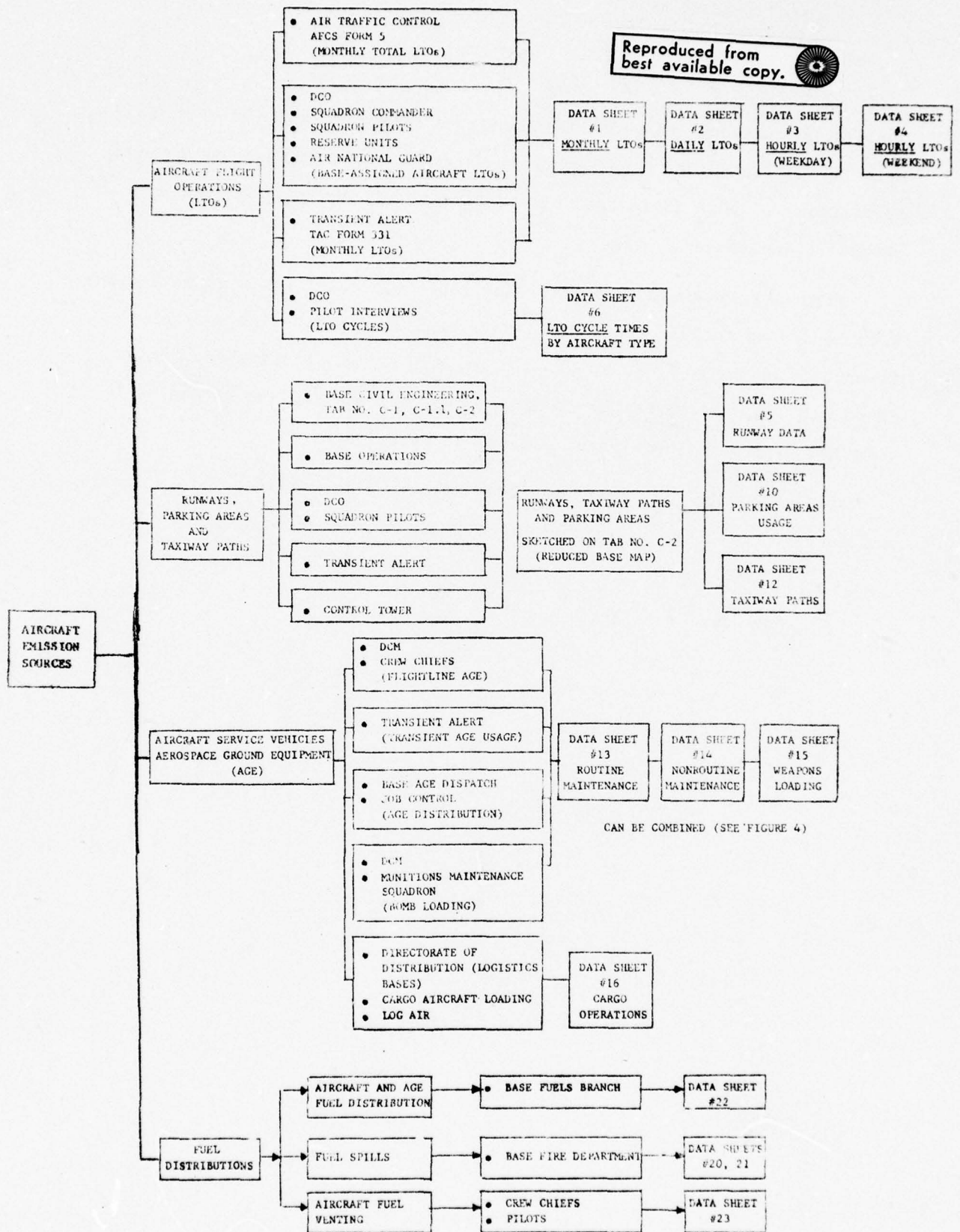
CARD 3 IS REPEATED FOR EVERY ENGINE TYPE BEING TESTED IN THIS RUNUP STAND AND THE NUMBER OF REPETITIONS MUST EQUAL THE TOTAL NUMBER OF ENGINE TYPES CODED IN CARD 2, COLUMN 8. CARD 2 WITH AN ASSOCIATED SET OF CARD(S) 3 IS REPEATED FOR EVERY RUNUP STAND USED AT THIS BASE AND THE NUMBER OF REPETITIONS MUST EQUAL THE VALUE CODED IN CARD , DATA SET 15.

Figure 10. (continued)

concise operational guideline is summarized from the current "AQAM Field Data Collection Guide," the number of data sheets to be used can possibly be reduced to about 13 instead of the current 23, and all data sheets should be renumbered.

Figure 11 shows the composite flow chart outlining the various actions recommended to collect operational data on aircraft emission sources. Seven data sheets (#7, 8, 9, 11, 17, 18, and 19) are eliminated. Data Sheet #13, 14, and 15 can be combined into one, and #20 and 21 can be combined into one. Data Sheet #22 can be redesigned.

The composite flow chart includes the specific outline of data items and data sources that is recommended for field application.



SECTION IV

TECHNIQUE OF MOTOR VEHICLE EMISSION INVENTORY DATA COLLECTION AND REDUCTION

A. Introduction

Motor vehicle sources are divided into area and line sources. Area sources describe regions where vehicular activity is not confined to a specific roadway, but rather distributed over a parking lot, many small roads, and so forth. These sources usually have well defined boundaries. The following kinds of area sources may be identified for each base:

- Major "on-base" housing areas, inside or adjacent to the base.
- Motor pool areas.
- Flight line areas with vehicular traffic.
- Warehouse areas.
- Areas of considerable private (civilian) vehicle parking concentrations--e.g. employment centers, hospital, BX, commissary.

The areas listed above are represented by square areas with sides oriented North-South and East-West.

Each square is assigned an identification number. The physical location of these area sources is described by: (1) geographic (i.e., UTM) coordinates of the centroid of the square, (2) average emission height of the pollutant source (0.5 meters for all area sources), (3) length of side of the square, and (4) initial vertical dispersion parameter. To complete the area source data sets, it is necessary to determine the distribution of gasoline and diesel-powered military vehicles, and civilian vehicles. It is also helpful to determine the

number of available parking spaces and the number of personnel residing and working in each square.

Line sources are vehicle emission sources along a defined path (roadway). Line sources are usually identified from 24-hour motor vehicle flow maps for the major roadways; these are usually available at most bases.² The weekend/weekday total travel volume was differentiated between "inner" and "outer" line sources ("outer" lines being those located outside the base gates and those lines 'inside the gates providing access to the main operating area of the base, and "inner" lines being those lines within the main working area of the base).

Current personnel and vehicle population statistics were obtained or estimated to distribute vehicle emission factors among area sources and line sources. When the available information was not current enough to be realistic, it was necessary to determine the change in the number of base personnel (from previous years when more detailed data may have been assembled). This permitted the computation of a population factor to update historical data. Table 2 describes the data required to complete each motor vehicle emission data set. The following information is usually available³ at most bases and must often be used to estimate vehicle line and area source data inputs:

- Number of military and civilian personnel currently working on base.
- Number of private vehicles registered by officers, and enlisted and civilian personnel.
- Vehicle ratio per person for officers, and enlisted and civilian personnel.

² Department of the Army Military Traffic Management Command Transportation Engineering Agency, 12388 Warwick Boulevard, P.O. Box 6276, Newport News, Virginia 23606.

³ Much of the information is summarized in the USAF Tab A-1 narrative prepared at each base.

Table 2. DATA COLLECTION REQUIREMENTS FOR COMPLETION
OF MOTOR VEHICLE EMISSION DATA SETS

Data Set	Required Data	Data Source(s)
<u>Airbase Area Source Geometries</u>		
20	<ul style="list-style-type: none"> • Identification of area sources • X and Y coordinates at source center • Length of one side of square 	Base map
<u>Hydrocarbon Breathing Losses</u>		
24	<ul style="list-style-type: none"> • Identification of parking areas: <ul style="list-style-type: none"> - Working area parking lots - Housing areas, dorms, BOQ - BX, commissary, hospital - Flight line area - Motor pool area • Fuel used by vehicles • No. military vehicles • Total number civilian and military vehicles parked in each area <ul style="list-style-type: none"> - No. employees - No. on-base housing/area - No. registered vehicles - No. employees by work zone - No. parking slots/area - Employee work schedule - Car pool factor 	<ul style="list-style-type: none"> Base map Map of parking slots^a Base Traffic-Engineering Study (T-E Study) BLISS report Housing office BLISS report T-E Study Tab A-1 Map of parking slots Base map Base Personnel office
<u>Military Motor Vehicle Area Sources</u>		
28	<ul style="list-style-type: none"> • Identification of military vehicle areas 	Base map

^aMaps of parking slots/lot were either available, estimated by sampling technique (parking slots were counted in a sample of parking lots, and remaining slots estimated by relative size of lot), or the number of parking available by work area was reported in base Traffic Engineering studies.

Table 2 (continued)

Data Set	Required Data	Data Source(s)
	<u>Military Motor Vehicle Area Sources</u>	
28	• Identification of military vehicle areas	Base map
	• Area size	
	• Speed limits in parking lots	
	• No. parking spaces/area	T-E Study
	• No. military vehicles	Base Transportation Office (BTO)
	• No. military area miles travelled	Map of parking slots
		BLISS report
	<u>Civilian Motor Vehicle Area Sources</u>	
29	• Identification of civilian vehicle areas	Base map
	• Area size	
	• Speed limits in parking lots	T-E Study
	• Parking lot turnover in BX, commissary, and hospital	
	• No. housing units	BTO
	• Operating hours in BX, commissary and hospital	
	• No. on-base personnel	
	• No. off-base personnel	T-E Study
	• No. civilian registered vehicles	
	• No. parking slots/area	Tab A-1
	• "Inner" and "outer" line source information	Base map
	• Car pool factor	Housing Office
	• No. employees per work area	Base Personnel Office
	Map of parking slots	
	See Data Set 32	
	T-E Study	
	Tab A-1	

Table 2 (continued)

Data Set	Required Data	Data Source(s)
<u>Airbase Line Source Geometries</u>		
30	<ul style="list-style-type: none"> • X and Y coordinates 	Base map
	<ul style="list-style-type: none"> • 24-hour volume counts of major line sources 	T-E Study Traffic flow maps or, if unavailable, results of origin- destination study Gate counts
	<ul style="list-style-type: none"> • Width of line sources 	BTO T-E Study
<u>Military Motor Vehicle Line Sources</u>		
31	<ul style="list-style-type: none"> • Identification of military line sources 	Base map
	<ul style="list-style-type: none"> • Length of line sources 	
	<ul style="list-style-type: none"> • Speed limits on line sources 	T-E Study BTO
	<ul style="list-style-type: none"> • Vehicle miles travelled (VMT) on line sources 	BLISS report
<u>Civilian Motor Vehicle Line Sources</u>		
32	<ul style="list-style-type: none"> • Speed limits on line sources 	T-E Study BTO
	<ul style="list-style-type: none"> • Identification of "inner" and "outer" line sources 	Base map
	<ul style="list-style-type: none"> • Length of line sources 	
	<ul style="list-style-type: none"> • 24-hour volume counts on major line sources 	T-E Study Traffic flow map Gate counts Actual volume counts on major streets

Table 2 (concluded)

Data Set	Required Data	Data Source(s)
	<ul style="list-style-type: none"> • Military VMT/line source 	BLISS report (Data Set 31)
	<ul style="list-style-type: none"> • Car pool factor (preferably, the number who drive to work/total number of personnel). • Number of officers and enlisted employees living in BOQs, dorms and on-base housing areas. • Number of employees on duty by hour of the day. 	

Military vehicle emission data must be differentiated according to class of vehicle or type of fuel burned. The following simplifications can be applied to all bases:

- There is only one class of civilian vehicle; all civilian vehicles burn gasoline.
- There are six classes of military vehicles. Classes I-V are gas-burning, while Class VI is usually diesel-burning. The following groups of military vehicles (from BLISS report computer outputs) make up the six classes of military vehicles:

Class I	DOD Groups A, E, F
Class II	DOD Groups G, H, P
Class III	DOD Groups B, I, J
Class IV	DOD Groups C, D, K, L
Class V	DOD Groups M, N
Class VI	DOD Group Q (Diesel portion only)

B. Area Sources--Specific Inputs

Four area source data sets must be completed for each base: Data Sets 20, 24, 28 and 29.

1. Data Set 20

This set tabulates the area source geometries previously described. From 8 to 28 area source squares were identified at each base:

<u>AFB</u>	<u>Number of Area Sources</u>
McDill	16
Nellis	14
Kelly	28
Tinker	19
Davis Monthan	20
Luke	14
Grissom	13
McGuire	19
Langley	8

2. Data Set 24

This set describes parking areas used by civilian and military motor vehicles in order to determine the evaporative emissions to the atmosphere from liquid fuel contained in parked vehicles. The sequence of steps given below was followed to approximate the number of parked vehicles per hour in each area source:

- Allocate the hourly numbers of personnel arriving and departing over a 24-hour weekday from base duty-hour schedules or gate counts.
- Determine when there is a prescribed minimum number of personnel on base and their total; then compute the actual number of personnel on base for all other hours by adding or subtracting arrivals and departures. (Because Luke AFB did not have any arrival/departure statistics, it was estimated that 80% of the personnel worked the day shift, and 20% the night shift.)

- Determine the number of civilian vehicles parked by on-duty personnel for each hour of the day: divide the current number of on-duty personnel by the car pool factor. 1976 personnel levels are obtained by multiplying base year levels by the "personnel factor" tabulated below:

<u>AFB</u>	<u>Base Year: Personnel Factor</u>	<u>Car Pool Factor</u>
McDill	1969: 0.873	1.2 persons/car
Nellis	1971: 1.19	Not available ^b
Kelly	1965: 0.95	1.43 persons/car
Tinker	1967: 0.775	1.5 persons/car
Davis Monthan	1969: 0.877	1.22 persons/car
Luke	1975: 1.000	1.2 persons/car
Grissom	1975: 1.000	1.3 persons/car
McGuire	1975: 1.000	1.3 persons/car
Langley	1975: 1.000	1.2 persons/car

- Compute the total number of parked vehicles by adding the Class I-VI military vehicles to the civilian vehicles computed above. All military vehicles were assumed to be parked on base for some portion of each hour of the day.
- Determine the number of "civilian" vehicles owned by on-base personnel by the following:

$$[(\text{No. officer housing units}) \times (\text{No. registered vehicles/officer})] + [(\text{No. dorm \& BOQ occupancies}) \times (\text{No. registered vehicles/enlisted employee})].$$

It was estimated that 95% of these vehicles were parked between 0600 and 2200; 100% otherwise.

- The total weekday number of vehicles parked on base by hour of day equals:
 $(\text{No. of military + civilian - parked vehicles}) + (\text{civilian vehicles parked by military personnel}).$
- The number of parked vehicles in an average week equals the total average weekday parked vehicles multiplied by 6.48. This value is based on a limited two-week traffic survey conducted at MacDill.

^b The national average car pool factor for 1.6 (Cooper, N., 1975: "Transportation and Air Quality Planning," APCA Specialty Conference on Long Term Maintenance of Clean Air Standards, February 3-4, Chicago.)

- Diesel-burning military vehicles (Class VI) are allocated to those area sources in which they normally operate; while the remaining vehicles are allocated over all area sources,⁴ by (1) the ratio of available parking spaces in each square, of (2) the ratio of size of the square to the total area. Parked vehicles were allocated for each base by:

<u>AFB</u>	<u>Parked Vehicles Allocated By:</u>
McDill	% size of squares to total area
Nellis	% size of squares to total area
Kelly	% available parking spaces
Tinker	% available parking spaces
Davis Monthan	% size of squares to total area
Luke	% available parking spaces
Grissom	% available parking spaces
McGuire	% size of squares to total area
Langley	% available parking spaces

- The average tank capacity was 70 liters for all civilian and Class I-V military vehicles. The capacity for military Class VI vehicles was 150 liters.
- The average decimal fraction a vehicle's tank is filled was 0.5 for all bases and all types of vehicles.

3. Data Set 28

This set describes the military vehicle activity in area sources dominated by military vehicles or where military and civilian vehicles are intermixed. Those squares totally excluded from this data set are residential. Those areas further excluded for Class VI vehicles

⁴ In the case of Nellis and Grissom AFBs, it was discovered that a major portion of Group Q vehicles were not diesel-burning vehicles. Thus the remaining gas-burning vehicles were evenly redistributed to the other five classes. It is suspected that other BLISS reports may also include gas-burning vehicles within Group Q vehicles.

included hospitals, BX, and office parking lots. Therefore, Class VI diesel-burning vehicle operations were primarily limited to warehouse and flight-line area sources. This data set was compiled using the following sequence of steps:

- Specification of combined hot-running emission factors with cold start emissions in each area source.
- Unless other information was provided, the average speed of military vehicles in BX, commissary, and hospital area sources was set to 15 mph; all other area sources equaled 20 mph.
- The military vehicle miles driven for each class were obtained from a BLISS report or other locally prepared records. It was estimated that 25% of all Class I and 40% of Class II-VI vehicles travelled throughout all areas, while Class VI vehicle miles were limited to warehouse and flight line area sources. Vehicle miles travelled (VMT) by each of the six classes were allocated among the areas by the ratio of area source size (or number of parking spaces) to the total area (or number of parking spaces).
- The number of military vehicles per class was also derived from BLISS reports. The national average number of trips per vehicle per day is 3.3 trips. Therefore the number of military vehicle hot soaks was assumed to be 3.3 per day or 852 per year ($3.3 \times 52 \text{ weeks} \times 5 \text{ days}$). It was estimated that there were 2 cold starts per day per vehicle or 520 per year ($2 \times 52 \text{ weeks} \times 5 \text{ days}$). The number of annual cold starts in each of the six classes was obtained by multiplying the number of vehicles by 520 cold starts. These cold starts were allocated to the area sources where each vehicle class operated according to the relative size of the area source.
- The number of annual hot soaks occurring in all military classes was determined by multiplying the total number of military vehicles by 852 hot soaks and then allocating these among the appropriate area sources.

- Allocations of VMT, cold starts and hot soaks were made at the bases by:

<u>AFB</u>	<u>Vehicle Miles</u>	<u>Cold Starts</u>	<u>Hot Soaks</u>
McDill	% area size	% area size	% area size
Nellis	% area size	% area size	% area size
Kelly	% area size	% park spaces	% park spaces
Tinker	% park spaces	% park spaces	% park spaces
Davis Monthan	% area size	% area size	% area size
Luke	% area size	% area size	% area size
Grissom	% area size	% park spaces	% park spaces
McGuire	% area size	% area size	% area size
Langley	% area size	% area size	% area size

Although over half the Davis-Monthan AFB fleet is Class II vehicles, the VMT by Class II vehicles was about 20% of typical Class II mileage per vehicle of other bases. The vehicle mileage figures were extracted from a quarterly BLISS report when the base was visited. Since these mileage figures were suspect, the Class II vehicle and mileage figures were compared to another (Davis-Monthan) annual BLISS report. The vehicle figures were found to be consistent with the quarterly BLISS report; however, the annual BLISS mileage figures for Class II were unusually high compared to Class II miles/vehicle at other bases and other class mileage figures at Davis-Monthan. It was decided to use the quarterly BLISS report with the somewhat low mileage counts, lacking more confident statistics for this base. Vehicle emission data reflect this low mileage in both area and line source data sets where data are categorized by military class. Total vehicle miles travelled by all Davis-Monthan military vehicles is realistic, however. At Grissom AFB, military VMT were redistributed to the six vehicle classes in accordance with the annual BLISS report when it was discovered that VMT figures taken from a quarterly BLISS report were unrealistically low for Class II.

4. Data Set 29

This set describes the civilian vehicle activity in area sources dominated by civilian vehicles (e.g., base housing areas) or where military and civilian vehicles are intermixed. Thus, civilian vehicles

can be found in nearly all squares on the base. It was assumed that there was only one class of civilian motor vehicles; all are light-duty, gas-burning vehicles. The following steps indicate the procedure for completing the data set:

- Combined hot running emission factors with cold start emissions is specified for each area source.
- Unless more specific information is available, the average speed of civilian vehicles in BX, commissary and hospital area sources is set at 15 mph; for all other area sources, it is 20 mph.
- Within residential area sources, the annual vehicle miles driven was determined by the following methodology:
 - (a) The approximate 1-way trip length (L) within a square was assumed to equal 1.5 times the length of the side of the square.
 - (b) The number of vehicles (N) in each area source was estimated as the number of housing units times the average number of registered vehicles per officer.
 - (c) The national average number of one-way trips per vehicle per day is 3.3. Therefore, the annual number of 1-way trips per vehicle (T) is 2409 trips ($3.3 \times 365 \text{ days} \times 2 \text{ trips}$).
 - (d) The number of civilian vehicle miles travelled in each residential area source is then computed as: $(L) \times (N) \times (T)$.
- If an entire square consisted of a BX, commissary, or hospital and reasonably accurate data were on hand, then the annual civilian vehicle miles was computed by:

$$(\text{l-way trip length}) \times (\text{No. l-way trips/hour}) \times (\text{No. operating hours/day}) \times (\text{No. operating days/week}) \times (52 \text{ weeks}).$$

The number of 1-way trips per hour is usually determined from information on parking lot turnover or number of employees and visitor trips per day.
- Computation of VMT on line sources for Data Sets 31 and 32 shall be completed prior to Data Set 29. After the total (i.e. military and civilian) VMT has been determined for "inner" and "outer"

line sources,⁵ travel can be apportioned. Civilian mileage data were estimated as the computed total mileage less military vehicle mileage. In the intermixed base parking/work areas, area source civilian VMT was estimated by:

- (a) Determine the fraction (a) of total "inner" line-source VMT accounted for by military Class I-VI vehicles by:
(Military "inner" link VMT/total military link VMT).
 - (b) The military Class I-VI VMT on "inner" line sources (b) equals: (Class I-VI line source VMT) x (a).
 - (c) Civilian "inner" line source VMT (c) equals: (Total "inner" line source VMT) minus (b).
 - (d) It was estimated that one third of the civilian "inner" line source VMT (c) was equal to the civilian mileage travelled in the inner work area sources.
 - (e) The civilian area source VMT was allocated to each area source by (1) percent employees who work in each square, (2) percent employees who park in each square, (3) percent of the parking spaces in each square, or (4) percent area size to total area.
- The number of annual cold starts by civilian vehicles in each area source was estimated by:
 - (a) BX, commissary or hospital areas:
(No. employees) x (1 cold start/day) x (No. operating days/week) x (52 weeks).
 - (b) On-base housing areas:
(No. vehicles) x (2 cold starts/day) x (365 days).
 - (c) Work areas:
(No. off-base personnel)/(car pool factor) = No. off-base cars \equiv (a);

⁵ See Data Set 32 for discussion on computation of line source annual vehicle miles travelled.

$(a) \times (1.1 \text{ cold starts/day/car at base})^6 = \text{No. cold starts on base by off-base personnel/day} \equiv (b);$
 $(b) \times (5 \text{ days/week}) \times (52 \text{ weeks}) = \text{No. annual cold starts by off-base personnel} \equiv (c);$
 $(\text{No. cars owned by on-base personnel}) \times (2 \text{ cold starts/day}) \times (365 \text{ days}) = \text{No. annual cold starts by on-base personnel} \equiv (d);$
 $(d) - (\text{No. annual cold starts in base housing areas} + (c)) = \text{No. annual cold starts in work area sources}.$

The cold starts in work areas were allocated to the appropriate squares similarly by: (1) percent employees that work in each square, (2) percent employees that park in each square, (3) percent of total parking spaces in each square, or (4) percent area size to total of all squares.

- The number of annual hot soaks by civilian vehicles in each area source was estimated by:

(a) BX, commissary or hospital areas:

$(\text{No. round trips/hour}) \times (\text{No. operating hours/day}) \times (\text{No. operating days/week}) \times (52 \text{ weeks}).$

(b) On-base housing areas:

$(\text{No. vehicles}) \times (3.3 \text{ round trips/day}) \times (365 \text{ days}).$

(c) Work areas:

$\text{No. annual cold starts} = \text{No. annual hot soaks}.$

- The method of allocating VMT, cold starts, and hot soaks was determined by the information available for each base:

⁶ Estimated value based on the sum of one cold start when finishing work at end of shift plus an assumed fraction (10%) of all cars that make one additional trip during the shift.

<u>AFB</u>	<u>Vehicle Miles</u>	<u>Cold Starts</u>	<u>Hot Soaks</u>
Mac Dill	% area size	% area size	% area size
Nellis	% area size	% area size	% area size
Kelly	% area size	% park spaces	% park spaces
Tinker	% park spaces	% park spaces	% park spaces
Davis-Monthan	% work in area	% work in area	% work in area
Luke	% area size	% area size	% area size
Grissom	% work in area	% park in area	% park in area
McGuire	% area size	% park spaces	% park spaces
Langley	% park in area	% park in area	% park in area

C. Line Sources--Specific Inputs

1. Data Set 30

This set provides the base line source geometries. The number of line sources per base ranged from 39 to 105. These were usually obtained from the traffic flow maps that generally provided 24-hour volume counts on each of the major line sources. (At Grissom AFB, however, no flow maps, gate counts, or 24-hour volume counts were available. All line source volumes had to be derived from estimated most likely routes from origin-destination approximations provided by a base employee. At Luke AFB, volumes were estimated by expanding peak hour traffic counts, provided for a portion of the line sources. In addition to major line sources within the gates of each base, some additional line sources carrying base personnel from "on-base" housing areas just outside the gates to the base were identified.)

<u>AFB</u>	<u>Number of Line Sources</u>
MacDill	57
Nellis	40
Kelly	70
Tinker	92
Davis-Monthan	47
Luke	57
Grissom	105
McGuire	39
Langley	48

Major roadways were divided into links or sections (i.e., line sources); each line source was then assigned an ID number that is used in each of the three line source data sets (30, 31 and 32). (In practice, both ends of each link were assigned an end-point number--links could share the same end-point number. Each line source was then defined by encoding the X and Y coordinate location at both ends.)

The average height of the emissions above the ground was assumed to be 0.5 meter for all line sources.

Information on the number of lanes or the width of most line sources was provided by base personnel (e.g., transportation office, security police). If line source widths data were not available, 12 feet widths per lane were assumed.

2. Data Set 31

This set describes the military motor vehicle activity on those base roadways either dominated by military vehicles or where military vehicles are intermixed with civilian vehicles. At the beginning of this study, military vehicles were considered as travelling uniformly on all line sources of the base and military VMT were dispersed on a per-mile basis. As the study progressed, it became apparent that a disproportionate number of military vehicle miles travelled were appearing on line sources whose sole purpose was to accommodate base-housing resident travel. A more careful assignment of military vehicle travel to only those line sources outside base housing areas was then conducted for the remaining bases (Nellis, Grissom and Langley AFB).

The total military vehicle miles travelled were already calculated from the BLISS report for each base. Seventy-five percent of Class I VMT were assumed on line sources, and 60% of Classes II-VI.

The military line source VMT was allotted to the appropriate line sources according to the link length. The fraction of VMT by each of the six classes was then applied to allocate the military line source VMT over the six military vehicle classes. At Luke AFB, Lockheed vehicles (42) and their mileage were included with Class II and V vehicles.

The vehicle emission factor for all classes of military vehicles was taken as that for hot running vehicles.

The average speed of military vehicles on each line was coded as the posted speed limit. The average speed was usually low within the base (20-30 mph) and considerably higher (40-50 mph) on those major roadways just outside the gates of the base.

3. Data Set 32

This set describes the civilian motor vehicle activity on those base roadways either dominated by civilian vehicles (i.e., on-base housing areas) or where military vehicles are intermixed with civilian vehicles (all other line sources).

Civilian VMT information was unavailable for all bases. The civilian VMT was obtained by determining the total (i.e. civilian plus military) VMT on each line source (available from the traffic engineering studies) and subtracting the travel conducted by military vehicles. The following calculations were performed:

- For each "outer" line source:
 $(305) \times (\text{average 24-hour weekday travel}) \times (\text{line source length in miles}) = \text{civilian and military annual VMT.}^7$
- For each "inner" line source:
 $(294) \times (\text{average 24-hour weekday travel}) \times (\text{line source length in miles}) = \text{civilian and military annual VMT.}^7$

⁷ These values reflect the decreased traffic volumes observed on Saturday and Sunday and are based on a limited survey conducted at MacDill AFB. Because similar data were not available at other bases, these values were used throughout.

- The annual civilian VMT is the difference between the total (i.e., civilian and military) annual VMT and the annual military VMT (Data Set 31) on each line source.
- The vehicle emission factor was taken as hot running for all line sources.
- The average speed on each line source was equal to the posted speed limit.

SECTION V
METHODS USED TO REDUCE AND CODE
THE COLLECTED INVENTORY DATA

The inventory data collected by SRI at each one of the nine selected AF bases were reduced and coded by the following two interrelated efforts.

1. Aircraft source emission data for Data Sets 4 through 10, and engine test facility source emission data for Data Sets 14 and 15 were reduced and tabulated for coding on intermediate data sheets obtained directly from the "Operations Guide", AFWL-TR-75-307. Examples are shown in Appendix 2. Completed intermediate data sheets were passed on to the keypunch operator.
2. Airbase military and civilian vehicle distribution data were entered also on intermediate data sheets obtained from the "Operations Guide" for subsequent processing by keypunch. All other data collected on motor vehicle source emissions were reduced and entered directly onto 80-column card punch coding forms.

Copies of the intermediate data sheets used by SRI are on file, and can be used in future inventory data collection programs.

SECTION VI
SUMMARY OF ENVIRON SOURCE EMISSION STUDIES

A. EPA National Emissions Data System (NEDS)

It is recommended that Section III-3 on Environ Sources in the "AQAM Field Data Collection Guide," AFWL-TR-75-220, be reorganized to incorporate the procedure required to reduce the EPA NEDS data to a form suitable for input into AQAM. NEDS lists computerized emissions data for all individual point sources that emit at least 100 tons per year of CO, NO_x, SO_x, hydrocarbons, or particulates. Area sources, however, are compiled on a countywide basis for both stationary and mobile sources. Thus, emission estimates for all area sources are summarized over the total county area.

SRI acquired NEDS data for those counties that characterized the areas surrounding the nine selected AF bases listed in Table 1.

The technique recommended to process the NEDS data was described by SRI in a recent proposal submitted to AFCEC.⁸ The specific problems associated with reducing the NEDS inventory for AQAM can be summarized as follows:

- Most of the counties studied contain many more point sources than the 100 maximum that AQAM can handle. For instance, several counties have over 1,000 card inputs. Each source is made up of an equivalent of at least six data cards. To obtain inputs for AQAM, 100 of the largest point sources surrounding an AF base must be selected. The remaining point

⁸ "Analysis of Off-base Emission Data for AQAM", Proposal for Research SRI No. ERU 76-60, prepared for ADTC/PMR, Eglin AFB, Florida 32542 (15 March 1976).

sources will then have to be integrated with the area source data. Criteria for this selection must be established.

- NEDS provides the total measured vehicle miles of travel (VMT) for several types of roads; it does not list emissions nor does it allocate those emissions to line sources. A total of 20 off-base line sources will have to be chosen, and the VMT for these links generated. The line source VMT must then be deducted from the county VMT, and the resultant value used to compute the remaining county vehicle emissions.
- NEDS area source data cards do not include emission estimates. What is available is fuel type and fuel usage for the various emitters. The emissions must be generated with the use of appropriate emission factors. It should be noted that the emissions shown on the NEDS data cards are obtained from the state's implementation plan (SIP) and are not calculated from the data.
- The calculated area source emissions must be summed over the entire county. These data must then be apportioned by population densities to smaller areas, and a total of 100 selected for AQAM.

It is apparent that criteria will have to be established whereby point sources and areas sources can be selected for AQAM.

Three major tasks are required to analyze and document the environment source emission data. Data Sheets 51 through 56 of the Field Data Collection Guide can be eliminated, and the input data for the AQAM can be entered directly onto coding sheets obtained from the "Operations Guide" AFWL-TR-75-307 (see Data Sets 34, 35, 36, and 37).

Task 1

Reformat the NEDS point source data, as required for Data Set 34, Off-base Point Sources. This task can be accomplished by examining each NEDS point source and selecting 100 of the largest emitters within a 20-km radius of the AF base. Once the sources are chosen, ID numbers can be assigned and the proper unit conversions can be made to complete Data Set 34. The sum of the remaining point source emissions can be integrated with the appropriate area source data.

Task 2

Calculate the off-base VMT and format data to complete Data Set 36, Off-base Roadway Sources. AQAM will accept a maximum of 20 off-base line sources. Only those roadways that convey the largest average daily traffic volume in the vicinity of the base should be selected. The VMT for these links can be determined and the values subtracted from the total NEDS county VMT. The line sources can then be coded to complete Data Set 36.

Task 3

Apportion the countywide area sources to grids, and format as required for Data Set 35, Off-base Area Sources. AQAM Data Set 35 (Option 3) permits the user to lump all source activities together and allows him to use whatever method is most appropriate or desirable to generate the annual emissions for each off-base area source. To complete this task, it will first be necessary to compute the total county area source emissions. This can be done by:

- Multiplying each emitter by the appropriate emission factor and summing the generated resultants.
- Adding together all point source emissions not accounted for in Task 1.
- Calculating the vehicle emissions obtained from the total county VMT produced in Task 2.
- Adding the above three values together.

After the county area source emissions have been obtained, it will be necessary to apportion these emissions to smaller grids by a population proportionality factor, assuming that area emissions are proportional to population.

In addition to an evaluation of the NEDS data, SRI collected available emissions studies and reports from local air pollution agencies (see Paragraph C), and from EPA. Using these studies and reports, emissions summary tables were prepared relevant to the nine airbases for which inventory data were collected. These tables are presented in Appendix C.

B. EPA Storage and Retrieval of Aerometric Data (SAROAD)

The Environmental Protection Agency (EPA) has promoted standard methods of handling air quality and related meteorological data to facilitate the exchange of technical information needed for air pollution abatement, control, and research. EPA has adopted a standard coding structure and formats known as Storage and Retrieval of Aerometric Data (SAROAD) to implement this standardization. EPA uses the SAROAD system in operation of the National Aerometric Data Bank, which contains air quality and meteorological data (in SAROAD format) supplied by various monitoring facilities across the United States. This data bank is a key element in the developing National Aerometric Data Information Service (NADIS), which is a systems approach to the collection, storage, and retrieval of local, state, and federal aerometric data to ensure that the appropriate control agencies receive comparable, accurate, and current data. SRI ordered the available SAROAD summaries for the various counties surrounding the nine airbases for which inventory data were collected.

Appendix D presents air quality summary tables for the nine airbases. The data listed in these tables were obtained from "Monitoring and Air Quality Trends Report, 1974," issued by the U.S. Environmental Protection Agency (EPA-450/1-76-001, February 1976).

C. Summary of Available Local APC Agency Reports

During each base visit, SRI personnel collected available air quality studies and summary tables published by local air pollution agencies. These studies include selected air quality measurements for 1975 and earlier years. Brief summaries of the collected studies follow. If any of the ambient air quality data from the studies are desired in AQAM evaluation, SRI has these reports on file.

- (1) "Air Quality Measurements, 1974," Hillsborough County Environmental Protection Commission, Tampa, Florida, 1974.

This report presents 1974 measurements by the County's air sampling network of 89 sampling stations. Average hourly values by year and by season are given for particulates, SO_2 , CO, O_3 , NO_2 and HC. A station location map and a listing of UTM coordinates are included.

- (2) "Air Quality Report, Phoenix Metropolitan Area, Maricopa County, Arizona," Environmental Planning Services, Highways Division, Arizona Department of Transportation, October, 1975.

This report includes 1974 summary data (e.g., annual average 1-hr and 24-hr maximum) for NO_2 , HC, particulates, CO, and oxidants. Site locations are indicated.

- (3) "Air Pollution in Tucson," Tucson Advisory Committee on Air Pollution, July, 1971.

This report includes air quality measurements of particulates, O_3 , NO_2 , and SO_2 made in Tucson prior to 1970. It gives the normal range and the maximum over three to five years.

- (4) "Air Contaminant Levels and Trends in Oklahoma County's Ambient Air," Oklahoma City-County Health Department.

This report presents a location listing and a map of sampling stations, and tabulates data on particulates and NO_2 (December 1971-November 1972), and total oxidants (March 1972-November 1972). Six hundred samples of SO_2 data reported values $\leq 10 \mu\text{g}/\text{m}^3$.

- (5) "Connie Data Summaries, 1974," Texas Air Control Board.

This report contains 1974 summary data of particulates, SO_2 , CO, HC obtained from the 12 continuous monitoring stations operated by the Texas Air Control Board in major metropolitan areas of Texas. Information concerning station design and operation may be obtained from the Air Quality Evaluation Division of the Texas Air Control Board, 8520 Shoal Creek Boulevard, Austin, Texas, 78758.

- (6) "Air Pollution Project 1974," San Antonio Metropolitan Health District.

The data presented in this report include values related to meteorological factors and air quality determinations for particulate matter and gaseous pollutants. Monthly, seasonal, and annual values are given for the meteorological factors.

The percent frequency distribution of values, second highest values, and maximum values for the year are given for total suspended particulate matter. Seasonal and annual arithmetic averages are given for total suspended particulate matter, organic soluble particulate matter, inorganic sulfate ion, inorganic nitrate ion, settled particulate matter, sulfation rate, and concentrations of sulfur dioxide, nitrogen dioxide, aldehydes, hydrogen sulfide, and ammonia. Annual geometric means are given for total suspended particulate matter and windblown particulates. A summary of data collected by the Texas Air Control Board continuous monitoring facility located in San Antonio is also presented.

- (7) "Transportation Control Plan Development for Clark County, Nevada," prepared by Transportation and Environmental Operations of TRW, Inc. under EPA Contract No. 68-02-1385. February 1975.

This report, which was made available to SRI on loan by the Clark County District Health Department, describes baseline (1972 and 1973) and projected (1977 and 1982) emission inventories for Clark County including Nellis AFB. The data are available in terms of emissions of carbon monoxide (1973 base year) and total hydrocarbons (1972 base year) on a 1 kilometer by 1 kilometer grid for Clark County. Some air quality data on CO and particulates from a monitoring site in downtown Las Vegas are tabulated.

No reports from local APC agencies near Langley AFB, Virginia were available. However, some information on air quality monitoring by the State Air Pollution Control Board in the Hampton-Newport News Area is described in the Environmental Narrative, Tab A-1 for Langley AFB. There are two state operated ambient air quality monitoring stations in the Langley AFB area. They are stations 179-G (Virginia Police Department, Hampton) and 179-F (Virginia School, Hampton). Available air quality data from these stations are listed below.

Station 179-G: Hampton, Virginia Police Dept.

Suspended Particulates

Range: 37-127 micrograms/cu m
Exceeded Primary Standard: 0 times
Geometric Mean: 44 micrograms/cu m (Quarter),
29 micrograms/cu m (12 mo.)

Station 179-F: Virginia School, Hampton, Virginia

Suspended Particulates

Range: 28-136 micrograms/cu m
Exceeded Primary Standard: 0 times
Geometric Mean: 55 micrograms/cu m (Quarter)

Sulfur Dioxide: Parts per million (24 hour average)

Range: 0.00-0.04
Number of samples greater than 0.14: 0
Arithmetic Mean: 0.01 (Quarter), 0.01 (12 mo.)

Ozone: Parts per million (1 hour average)

Range: 0.000-0.145
Number of samples greater than 0.08: 141
Number of samples: 2,079
Arithmetic Mean: 0.038 (Quarter)

Carbon Monoxide: Parts per million (1 hour average)

Number of samples greater than 35: 0
Number of samples: 2,135
Maximum sample: 11
Arithmetic Mean: 5.3 (Quarter)

SECTION VII
FINAL NARRATIVE

A. General

Working documents and summary data for the nine selected Air Force bases visited by SRI personnel are described in this section.

All base maps showing UTM coordinate grids and locations of all area and line sources documented in the inventory data collection program have been forwarded to AFCEC/EV.

The completed Data Sheets 1 through 23, and 25 and 26 used to collect the operational field data on aircraft sources and on trim pads for each base will remain on file at SRI together with the corresponding coding sheets for Data Sets 4 through 10, 14 and 15.

The airbase source emission data collected at Langley AFB, and all military and civilian motor vehicle data will be filed at SRI also. These data are available upon request.

B. Summary Data

Table 3 presents the demographic data summary for the nine U.S. Air Force bases visited by SRI personnel. The data include assigned military personnel, civilian employees, family housing and dormitory residents, the number of retired military personnel in the area, and the number of civilian vehicles currently registered on base.

In many instances, these data had to be estimated or had to be obtained from relatively outdated records. Thus, relative variations in the numbers from base to base rather than absolute values should be considered.

Table 3. DEMOGRAPHIC DATA SUMMARY FOR THE NINE SELECTED
U.S. AIR FORCE BASES VISITED BY SRI PERSONNEL

Information	AF BASE								
	MacDill	Nellis	Kelly	Davis-Monthan	Tinker	Luke	Grisson	McGuire	Langley
Assigned Military Personnel	5,975	8,600	4,357	7,675	3,630	6,500 ^(f)	2,877	6,368 ^(g)	8,472
Assigned Civilian Personnel	945	1,500	19,833	1,860	17,289	1,600	966	1,271	6,326
Retired Military Personnel in Area	13,800 (vehicles)	7,000	(e)	4,880 (e) (vehicles)	(e)	2,065 (vehicles)	(e)	(e)	(e)
Number of Family Housing Units	805	1,497	550 ^(d)	1,255	532	875	1,137	2,182	604
Number of Mobile Home Spaces	100	100	0	125	(e)	(e)	0	0	28
Number of Registered Privately Owned Vehicles	25,000 ^(b)	14,507 ^(b)	28,227 ^(d)	20,561 ^(c)	39,997 ^(a)	13,672	6,359	(e)	(e)
Dormitory Units and BQs	2,312 ^(b)	2,667	1,700 ^(d)	2,413	893	1,700	1,722	6,263	1,977

(a) 1967 data, population has decreased since then

(b) 1971 data

(c) 1969 data

(d) 1966 data

(e) Not obtained

(f) 2,450 live on base

275 Officers

2,177 Enlisted

(g) 3,035 live on base

570 Officers

2,415 Airmen

C. Methodology Used for Grouping Aircraft Types and LTOs

At most Air Force bases visited, the number of aircraft types making up an appreciable percentage of the total base sorties exceeded the maximum allowable number of eight used in the AQAM inventory. Particularly at Logistics Command bases such as Kelly and Tinker AFB, no single aircraft type accounted for a large percentage of the total sorties; rather, several types each flew about 5 to 10 percent of the sorties. Since the AQAM will allow only eight aircraft types, it was necessary to combine types that have similar engines and emission characteristics.

In grouping the aircraft, four basic types were first identified: (1) reciprocating aircraft, (2) turboprop aircraft, (3) light aircraft (e.g., Cessna, Beech, etc.), and (4) jet aircraft. To fill the remaining four categories, the jet aircraft were subdivided into five categories, according to total thrust and emission characteristics. The following are the eight basic ID number categories which were used, along with the composite aircraft types and weighting factors.

● C-97 (reciprocating) - ID 27

= C-4 = 2C-47 = 2C-54 = C-118 = C-117 = 1/2 C-121 = C-123 = C131
= DC-3 = 2E-1 = 3/2 E-2 = 2P-2 = 3/2 S-2 = 4T-28 = T-29 = TC-4
= 2C-7

● C-130 (turboprop) - ID 21

C-133 = L-402 = P-3 = 2S-3

● O-1 (light) - ID 35

= AV-8 = B-212 = BE-18 = BE-23 = BE-35 = BE-55 = C-150 = C-170
= C-172 = C-180 = C-205 = C206 = C-207 = C-337 = C-340 = CT-30
= CV-58 = CV-580 = M-5 = ML-5 = N-265 = O-2 = O-7 = O-12 = OV-1
= OV-10 = OV-58 = PA-23 = PA-28 = PA-34 = T-34 = T-42 = U-3
= U-8 = U-11 = U-21

- C-9 (jet) - ID 20
= T-43
- C-135 (jet) - ID 23
= 1/2 B-52 = 1/2 C-5 = C-141 = VC-137
- F-4 (jet) - ID 12
= A-5 = F-14 = F-101 = 2F-104 = F-111
- F-100 (jet) - ID 6
= A-3 = A-6 = A-7 = 1/2B-57 = C-140 = F-8 = F-102 = 2/3 F-105
= 2/3 F-106
- T-38 (jet) - ID 32
= A-4 = A-37 = F-5 = T-2 = T-33 = 4T-37 = T-39

The number of sorties for each aircraft type were tabulated for two months from flight logs. For each of the two months, the number of sorties in each of the aircraft ID number categories was found by combining aircraft types guided by the above equations. These equations cannot be used directly, since they are stated in terms of thrust. To put them in a form suitable for use in determining the number of sorties, the reciprocal of each multiplier (weighting factor) was taken. For example, assume that during the month of January there were 80 F-4 sorties and 20 F-104 sorties. The equation says $F-4 = 2 F-104$, and thus the number of sorties in the F-4 category would be 90 (80 + 10) since it takes two F-104 sorties to equal one F-4 sortie (i.e., 20 F-104 sorties equals 10 F-4 sorties).

Thus, the number of sorties in each category was calculated for each of the two months, and the percent distribution of sorties by aircraft type was then found for each month. These values were averaged for the two months to produce a sortie distribution that could be applied to the total operations figure for each month to yield the monthly sorties by aircraft type.

The above eight composite categories were used at Kelly and Tinker AFB. At other bases, the eight aircraft groupings given above were

not entirely appropriate. For instance, in some cases two aircraft types that could be grouped together each accounted for an appreciable percentage of the total sorties. When this occurred, the two aircraft types were assigned separate ID numbers for input to the model, while other aircraft types associated with smaller numbers of sorties were grouped together.

The eight composite classes presented in the above equations were therefore not used exclusively at all bases but were used as a guideline and were adapted to the requirements of each base.

Appendix A

EXAMPLE OF INTRODUCTORY INFORMATION FOR
PREPARATION OF BASE VISIT

29 December 1975

57CSG/DEEE

Attn: Mr. Daily

Base Environmental Coordinator

Nellis AFB, Nevada 89191

Dear Sir:

Enclosed is a draft copy of the tentative time schedule we discussed in our recent telephone conversation of 12-29-75. An identification of principal contacts and areas of relevant data sources is attached also.

We are looking forward to seeing you on Monday, 5 January.

Sincerely,



Bill Viezee
Senior Research Meteorologist
Atmospheric Sciences Laboratory

BV:ss

Enclosure

SUGGESTED TIME SCHEDULE FOR SRI VISIT

Monday, 5 January 1976

- Base Civil Engineering
- Base Briefing (30 minutes)
- Fire Department (Fuel spillage, data sheet 20,21)
- Fuels Branch (Fuel Usage, data sheet 22)
- Base Auditor (military vehicle data)

Tuesday, 6 January 1976

- Aircraft LTO distribution (base-assigned and transient aircraft, data sheets 1 through 12 and 23)

Wednesday, 7 January 1976

- Aircraft LTOs continued
- Usage of aircraft service vehicles and auxiliary ground equipment (AGE, data sheets 13 through 19)

Thursday, 8 January 1976

- Military motor vehicles (Base transportation, data sheets 43 through 45)
- Civilian vehicles (data sheets 46 through 49)

Friday, 9 January 1976

- Trim pads (data sheet 25)
- Downtown EPA

PRINCIPAL CONTACTS REQUIRED FOR AF EMISSION SOURCE
DATA COLLECTION PROGRAM

<u>Principal Contact</u>	<u>Relevant Information</u>
• Base Civil Engineering (Environmental Coordinator)	Comprehensive Plan. Base Maps C-1.1, F-1.1, B-1,2, E-3, G-7. Data on Aircraft Parking Areas, Taxiways and Runways
• Deputy Commander for Operations (DCO)	Flight Operations by Aircraft Type. Parking Areas, Taxiway Paths and Runway Usage
• Deputy Commander for Maintenance (DCM)	Aircraft Engine Types. AGE Usage for Arriving and Departing Aircraft
• Transient Alert	Transient Flight Operations
• Operational Maintenance Squadron (OMS Crew Chiefs)	Flight Line Usage of AGE
• Base Fire Department (Fire Chief)	Fuel Spillage
• Fuels Management Branch	A/C Refueling Operations
• AICUZ	Available Data on Aircraft Operations
• Base Bioenvironmental Engineer	Available Air Emissions Inventory Studies (Environmental Narrative)
• Propulsion Branch	Trim Pads
• Transportation Division	Usage of Military Vehicles
• Security Police	Usage of Civilian Vehicles

Appendix B

SAMPLES OF INTERMEDIATE DATA SHEETS
USED BY SRI IN THE REDUCTION OF
AIRCRAFT SOURCE EMISSION INVENTORY DATA

DATA SET 4

FORMAT(514)

CARD NUMBER 1

<u>card columns</u>	<u>unit</u>	<u>definition</u>	<u>remarks</u>	<u>totals</u>
4	-	Total number of aircraft types (MAXIMUM OF 8, MINIMUM OF 1)	Data sheet 1, Column 1	
8	-	Total number of runways used (MAXIMUM OF 6, MINIMUM OF 1)	Data sheet 5, Row 1	
12	-	Total number of parking areas (MAXIMUM OF 6, MINIMUM OF 1)	Base map; Data sheet 10	
16	-	Total number of special case wind conditions (see Appendix III) (MAXIMUM OF 3, MINIMUM OF 0)	Data sheet 5, Row 8	
19-20	-	Total number of taxiway path segments (MAXIMUM OF 25, MINIMUM OF 1)	Base map; Data set 7 lists coordinates of all segments	

DATA SET 5

A/C

FORMAT(6X,12,3F8.0)

CARD NUMBER 1

<u>card columns</u>	<u>unit</u>	<u>definition</u>	<u>remarks</u>	<u>totals</u>
7-8	-	Aircraft identification number (choose from Table 3).	From Table 3, pick from Data sheet 1	
9-16	-	Annual number of arrival operations for this aircraft.	Data sheet 1, Column 14	
17-24	-	Annual number of departure operations for this aircraft.	"	
25-32	-	Arrival number of touch and go cycles for this aircraft.	Data sheet 1, Column 14 number in parenthesis	

THIS CARD IS REPEATED FOR EVERY AIRCRAFT TYPE DEFINED AT THIS
BASE AND THE NUMBER OF REPETITIONS MUST AGREE WITH THE TOTAL
NUMBER OF AIRCRAFT DEFINED IN DATA SET 4.

DATA SET 9

FORM T(5F8.3) A/C type

CARD NUMBER 3

<u>card columns</u>	<u>unit</u>	<u>definition</u>	<u>totals</u>
1-8	Kg/Departure	Carbon monoxide emissions resulting from gasoline consuming AGE equipment servicing this OUTGOING aircraft.	
9-16	Kg/Departure	Hydrocarbon emissions resulting from gasoline consuming AGE equipment servicing this OUTGOING aircraft.	
17-24	Kg/Departure	Nitrogen oxide emissions resulting from gasoline consuming AGE equipment servicing this OUTGOING aircraft.	
25-32	Kg/Departure	Particulate emissions resulting from gasoline consuming AGE equipment servicing this OUTGOING aircraft.	
33-40	Kg/Departure	Sulfur oxide emissions resulting from gasoline consuming AGE equipment servicing this OUTGOING aircraft.	

This card is repeated for every aircraft used at this airbase and the number and order of repetitions must agree with the total number of aircraft types defined in card 1, data set 4.

Appendix C

EMISSIONS SUMMARY TABLES
FOR THE NINE AIRBASES VISITED BY SRI

EMISSIONS SUMMARY TABLE *

LUKE AFB

TONS/YR	FUEL COMBUSTION	TRANSPORTATION	SOLID WASTE	INDUSTRIAL	OTHER
PARTICULATE	883	6017	936	13667	32287
SO ₂	54	3572	30	651	-
CO	403	581503	3281	2027	540
HC	1396	88228	114	24750	32891
NO _x	14283	51841	159	N	18

* Data compiled from SIP representing Maricopa County (Phoenix)
N = negligible (< 1 ton/yr)

EMISSIONS SUMMARY TABLE*

DAVIS-MONTHAN AFB

TONS/YR	FUEL COMBUSTION	TRANSPORTATION	SOLID WASTE	INDUSTRIAL	OTHER
PARTICULATE	952	2599	156	11145	22187
SO ₂	42	1079	16	7098	-
CO	5	150455	1353	31	451
HC	N	22316	18	6704	29139
NO _x	20331	12973	29	620	15

* Data compiled from SIP representing Pima County (Tucson)
 N = negligible (< 1 ton/yr)

EMISSIONS SUMMARY TABLE *

NELLIS AFB

TONS/YR	FUEL COMBUSTION	TRANSPORTATION	SOLID WASTE	INDUSTRIAL	OTHER
PARTICULATE	80	3212	383	7559	37736
SO ₂	50	803	0	46	0
CO	7	75738	1945	73	0
HC	4	8126	116	850	2555
NO _x	1113	7565	225	3	0

* 1970 data compiled from "The National Air Monitoring Program: Air Quality and Emissions Trends," Annual Report, Volume II (EPA-450/1-73-001-b) representing AQCR 013

EMISSIONS SUMMARY TABLE *

TINKER AFB

TONS/YR	FUEL COMBUSTION	TRANSPORTATION	SOLID WASTE	INDUSTRIAL	OTHER
PARTICULATE	1954	3934	1580	7931	0
SO ₂	3364	2507	99	0	0
CO	822	357369	8395	99	0
HC	2190	76689	2963	4746	829
NO _x	31764	42245	593	1	0

* 1970 data compiled from "The National Air Monitoring Program: Air Quality and Emissions Trends," Annual Report, Volume II (EPA-450/1-73-001-b) representing AQCR 184.

EMISSIONS SUMMARY TABLE *

GRISSOM AFB

TONS/YR	FUEL COMBUSTION	TRANSPORTATION	SOLID WASTE	INDUSTRIAL	OTHER
PARTICULATE	22308	1597	4395	12008	0
SO ₂	40025	1705	273	25	0
CO	0	0	0	0	0
HC	0	0	0	0	0
NO _x	0	0	0	0	0

* 1970 data compiled from "The National Air Monitoring Program: Air Quality and Emissions Trends," Annual Report, Volume II (EPA-450/1-73-001-b) representing AQCR 076.

EMISSIONS SUMMARY TABLE *

McQUIRE AFB

TONS/YR	FUEL COMBUSTION	TRANSPORTATION	SOLID WASTE	INDUSTRIAL	OTHER
PARTICULATE	5171	3679	1296	1797	0
SO ₂	52102	10068	276	3541	0
CO	1226	221770	1842	0	0
HC	2165	32798	553	2129	0
NO _x	43667	37687	552	698	0

* 1970 data compiled from "The National Air Monitoring Program: Air Quality and Emissions Trends," Annual Report, Volume II (EPA-450/1-73-001-b) representing AQCR 150.

EMISSIONS SUMMARY TABLE*

KELLY AFB

TONS/YR	FUEL COMBUSTION	TRANSPORTATION	SOLID WASTE	INDUSTRIAL	OTHER
PARTICULATE	981	4160	778	33177	-
SO ₂	545	2085	161	13048	-
CO	283	257723	1466	40	-
HC	2883	51062	699	1470	-
NO _x	13522	47278	217	7	-

* Data compiled from 1974 annual data summary by Texas Air Control Board.

EMISSIONS SUMMARY TABLE *

LANGLEY AFB

TONS/YR	FUEL COMBUSTION	TRANSPORTATION	SOLID WASTE	INDUSTRIAL	OTHER
PARTICULATE	14307	1199	1311	55314	0
SO ₂	41061	574	114	11902	0
CO	4060	267328	3586	150	0
HC	2061	32226	1741	1397	22474
NO _x	8598	27836	286	749	0

* 1970 data compiled from "The National Air Monitoring Program: Air Quality and Emissions Trends," Annual Report, Volume II (EPA-450/1-73-001-b) representing AQCR 224.

EMISSIONS SUMMARY TABLE *

MACDILL AFB

TONS/YR	FUEL COMBUSTION	TRANSPORTATION	SOLID WASTE	INDUSTRIAL	OTHER
PARTICULATE	27575	3003	33	-	1914
SO ₂	292958	2044	10	-	7
CO	9455	175536	179	-	5889
HC	9486	31383	113	-	1442
NO _x	79810	30332	8	-	312

* 1974 data compiled from report prepared by Hillsborough County Environmental Protection Commission, Tampa, Florida.

Appendix D

AIR QUALITY SUMMARY TABLES
FOR THE NINE AIR BASE
VISITED BY SRI

AQ SUMMARY TABLE

FOR LUKE AFB

POLLUTANT	RANGE OF PEAK 1-HR CONC.	RANGE OF PEAK 8-HR CONC.	RANGE OF PEAK 24-HR CONC.	RANGE OF ANNUAL MEAN CONC.	NO. OF AQ STATIONS	PEAK 1-HR * CONC.	PEAK 8-HR * CONC.	PEAK 24-HR * CONC.	MEAN ANNUAL * CONC.	NEAREST STATION LOCATION
PARTICULATES ($\mu\text{g per m}^3$)	—	—	164 - 762	60 - 189	15	—	—	226	123	Lichtfield Park
SO_2 ($\mu\text{g per m}^3$)	—	—	20 - 329	6 - 18	2	—	—	329	18	Mesa
CO (ppm per m^3)	20 - 100	11 - 25	—	—	5	17	9	—	—	Glendale 6000 W. Olive
NO_2 ($\mu\text{g per m}^3$)	373 - 564	—	130 - 184	51 - 104	3	376	—	154	75	Phoenix 1845 E. Roosevelt
O_3 ($\mu\text{g per m}^3$)	69 - 294	—	—	—	5	234	—	—	—	Glendale 6000 W. Olive

* Individual air quality statistics for the monitor geographical by closest to Air Force base; these data are not necessarily the best representative values.

— Not available

Reproduced from
best available copy.



AQ SUMMARY TABLE

FOR DAVIS-MONTHAN AFB

POLLUTANT	RANGE OF PEAK 1-HR CONC.	RANGE OF PEAK 8-HR CONC.	RANGE OF PEAK 24-HR CONC.	RANGE OF ANNUAL MEAN CONC.	NO. OF AQ STATIONS	PEAK 1-HR * CONC.	PEAK 8-HR * CONC.	PEAK 24-HR * CONC.	MEAN ANNUAL CONC.	NEAREST STATION LOCATION
PARTICULATES ($\mu\text{g per m}^3$)	—	—	92 - 546	60 - 107	11	—	—	142	80	Davis Monthan AFB
SO_2 ($\mu\text{g per m}^3$)	—	—	39 - 82	6 - 10	4	—	—	52	7	22nd and Graycroft, Tucson (13 miles N of Base)
CO (mg per m^3)	22 - 28	10 - 13	—	1.4 - 2.2	3	26	13	—	2.2	22nd and Graycroft, Tucson (13 miles N of Base)
NO_2 ($\mu\text{g per m}^3$)	188 - 226	—	65 - 165	39 - 59	3	226	—	136	56	22nd and Graycroft, Tucson (13 miles N of Base)
O_3 ($\mu\text{g per m}^3$)	186 - 294	—	—	—	3	294	—	—	—	22nd and Graycroft, Tucson (13 miles N of Base)

* Individual air quality statistics for the monitor geographical by closest to Air Force base; these data are not necessarily the most representative values.

— Not available

AIR SUMMARY TABLE

FOR NELLIS AFB

POLLUTANT (µg per m ³)	RANGE OF PEAK 1-HR CONC.	RANGE OF PEAK 8-HR CONC.	RANGE OF PEAK 24-HR CONC.	RANGE OF ANNUAL MEAN CONC.	NO. OF AQ STATIONS	PEAK 1-HR * CONC.	PEAK 8-HR * CONC.	PEAK 24-HR * CONC.	MEAN ANNUAL CONC.	MONITOR STATION LOCATION
PARTICULATES (µg per m ³)	—	—	61 - 427	47 - 134	19	—	—	250	55	Nellis AFB
SO ₂ (µg per m ³)	—	—	—	—	0	—	—	—	—	
CO (mg per m ³)	19 - 57	16 - 17	—	—	2	57	16.3	—	2.5	Fire Station - Downtown Las Vegas
NO ₂ (µg per m ³)	—	—	83 - 177	—	2	—	—	177	—	Fire Station Downtown Las Vegas
O ₃ (µg per m ³)	432 - 832	—	—	—	2	432	—	—	—	Fire Station Downtown Las Vegas

* Individual air quality statistics for the monitor geographical by closest to Air Force base; these data are not necessarily the most representative values.

— not available

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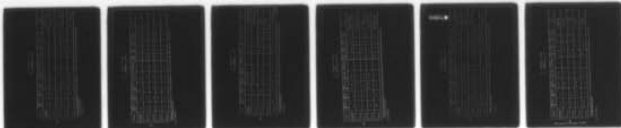
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AQ SUMMARY TABLE

FOR TINKER AFB

POLLUTANT	RANGE OF PEAK 1-HR CONC.	RANGE OF PEAK 8-HR CONC.	RANGE OF PEAK 24-HR CONC.	RANGE OF ANNUAL MEAN CONC.	NO. OF AQ STATIONS	PEAK 1-HR * CONC.	PEAK 8-HR * CONC.	PEAK 24-HR * CONC.	MEAN ANNUAL CONC.	NEAREST STATION LOCATION
PARTICULATES ($\mu\text{g per m}^3$)	—	—	51 - 361	32 - 107	22	—	—	148	52	300 NIS-America US 40, N of Tinker
SO ₂ ($\mu\text{g per m}^3$)	—	—	2 - 5	2 - 4	13	—	—	5	4	SE 7th and High, OKC
CO (mg per m^3)	19 - 22	11 - 13	—	—	2	19	13	—	—	2045 NW 10, OKC
NO ₂ ($\mu\text{g per m}^3$)	—	—	34 - 90	—	7	—	—	56	—	SE 7th and High, OKC
O ₃ (i) ($\mu\text{g per m}^3$)	—	—	94 - 181	18 - 28	8	—	—	96	21	300 NIS-America US 40, S of Tinker

* Individual air quality statistics for the monitor geographical by closest to Air Force base; these data are not necessarily the most representative values.

March to November 1972

Not available

AQ SUMMARY TABLE

FOR GRISCOM AFB

POLLUTANT	RANGE OF PEAK 1-HR CONC.	RANGE OF PEAK 8-HR CONC.	RANGE OF PEAK 24-HR CONC.	RANGE OF ANNUAL MEAN CONC.	NO. OF AQ STATIONS	PEAK 1-HR * CONC.	PEAK 8-HR * CONC.	PEAK 24-HR * CONC.	MEAN ANNUAL CONC.	NEAREST STATION LOCATION
PARTICULATES ($\mu\text{g per m}^3$)	—	—	—	—	—	—	—	79	65	Kokomo
SO ₂ ($\mu\text{g per m}^3$)	—	—	—	—	—	—	—	81	20	Kokomo
CO (mg per m^3)	—	—	—	—	—	—	—	—	—	
NO ₂ ($\mu\text{g per m}^3$)	—	—	—	—	—	—	—	60	24	Kokomo
O ₃ ($\mu\text{g per m}^3$)	—	—	—	—	—	—	—	—	—	

* Individual air quality statistics for the monitor geographical by closest to Air Force base; these data are not necessarily the most representative values.

— not available

AQ SUMMARY TABLE

FOR MCQUEE AFB

POLLUTANT	RANGE OF PEAK 1-HR CONC.	RANGE OF PEAK 8-HR CONC.	RANGE OF PEAK 24-HR CONC.	RANGE OF ANNUAL MEAN CONC.	NO. OF AQ STATIONS	PEAK 1-HR * CONC.	PEAK 8-HR * CONC.	PEAK 24-HR * CONC.	MEAN ANNUAL CONC.	NEAREST STATION LOCATION
PARTICULATES ($\mu\text{g per m}^3$)	—	—	90 - 141	26 - 45	8	—	—	122	45	Ocean County, N.J. 15 miles E of McQuire
SO ₂ ($\mu\text{g per m}^3$)	—	—	104 - 206	36 - 40	2	—	—	104	36	Trenton, N.J. 15 miles NW of McQuire
CO (mg per m ³)	24	13.9	—	3.2	1	24	13.9	—	3.2	Trenton
NO ₂ ($\mu\text{g per m}^3$)	—	—	107	59	1	—	—	107	59	Trenton
O ₃ ($\mu\text{g per m}^3$)	452	—	—	—	1	452	—	—	—	Trenton, N.J. 15 miles NW of McQuire

* Individual air quality statistics for the monitor geographical by closest to Air Force base; these data are not necessarily the most representative values.

— not available

AQ SUMMARY TABLE

FOR KELLY AFB

POLLUTANT	RANGE OF PEAK 1-HR CONC.	RANGE OF PEAK 8-HR CONC.	RANGE OF PEAK 24-HR CONC.	RANGE OF ANNUAL MEAN CONC.	NO. OF AQ STATIONS	PEAK 1-HR * CONC.	PEAK 8-HR * CONC.	PEAK 24-HR * CONC.	MEAN ANNUAL CONC.	NEAREST STATION LOCATION
PARTICULATES ($\mu\text{g per m}^3$)	—	—	115 - 241	43 - 83	8	—	—	214	83	2242 W. South Cross 2.5 miles E of Kelly
SO ₂ ($\mu\text{g per m}^3$)	—	—	2 - 139	0 - 2	8	—	—	139	0.7	2242 W. South Cross 2.5 miles E of Kelly
CO (mg per m^3)	5	2.6	—	—	1	5	2.6	—	—	919 Gumbler 9 miles ENE of Base
NO ₂ ($\mu\text{g per m}^3$)	—	—	31 - 139	26 - 113	5	—	—	93	54	2242 W. South Cross 2.5 miles E of Kelly
O ₃ ($\mu\text{g per m}^3$)	298	—	—	38	1	298	—	—	38	919 Gumbler 9 miles ENE of Base

* Individual air quality statistics for the monitor geographical by closest to Air Force base; these data are not necessarily the best representative values.

— not available



AQ SUMMARY TABLE

FOR LANGLEY AFB

CONTAMINANT	RANGE OF PEAK 1-HR CONC.	RANGE OF PEAK 8-HR CONC.	RANGE OF PEAK 24-HR CONC.	RANGE OF ANNUAL MEAN CONC.	NO. OF AQ STATIONS	PEAK 1-HR * CONC.	PEAK 8-HR * CONC.	PEAK 24-HR * CONC.	MEAN ANNUAL CONC.	STATION LOCATION
PARTICULATES ($\mu\text{g per m}^3$)	—	—	96 - 178	27 - 69	10	—	—	28 - 136	35	Virginia School Hampton
SO ₂ ($\mu\text{g per m}^3$)	—	—	2 - 550	13 - 65	18	—	—	105	76	Virginia School Hampton
CO ($\mu\text{g per m}^3$)	17 - 23	5 - 13	—	0.9 - 2.0	3	12.6	—	—	6.0	Virginia School Hampton
NO ₂ ($\mu\text{g per m}^3$)	—	—	36 - 235	41 - 43	3	—	—	—	—	—
O ₃ ($\mu\text{g per m}^3$)	293 - 382	—	—	—	2	299	—	—	76	Virginia School Hampton

* Individual air quality statistics for the monitor geographical by closest to Air Force base; these data are not necessarily the most representative values.

— Not available

AQ SUMMARY TABLE

FOR MACDILL AFB

POLLUTANT	RANGE OF PEAK 1-HR CONC.	RANGE OF PEAK 8-HR CONC.	RANGE OF PEAK 24-HR CONC.	RANGE OF ANNUAL MEAN CONC.	NO. OF AQ STATIONS	PEAK 1-HR * CONC.	PEAK 8-HR * CONC.	PEAK 24-HR * CONC.	MEAN ANNUAL CONC.	NEAREST STATION LOCATION
PARTICULATES (-g per m ³)	—	—	100 - 277	60 - 84	7	—	—	197	84	Davis Island Coast Guard
SO ₂ (-g per m ³)	—	—	120 - 263	17 - 32	6	—	—	122	17	MacDill AFB Sewage Plant
CO (-g per m ³)	15 - 22	5 - 9	—	1 - 3	2	15	6	—	0.8	Davis Island Coast Guard
NO ₂ (-g per m ³)	—	—	18 - 130	7 - 47	39	—	—	62	19	MacDill AFB Sewage Plant
O ₃ (-g per m ³)	330 - 350	—	—	40 - 56	3	350	—	—	55	Davis Island Coast Guard

* Individual air quality statistics for the monitor geographical by closest to Air Force base; these data are not necessarily the most representative values.

— not available